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ABSTRACT

The collective theme of these seven essays calls for a new perspective on science and technology so that they are dedicated to the pursuit of truth and human liberties rather than to power, control, and exploitation. The authors of the essays are with various international development and research centers and projects in seven countries. John Galtung discusses technology not merely as a mode of production but as containing economic, social, cultural, and cognitive structures. Francisco R. Sagasti examines the role of science and technology in development, and presents a strategy for endogeneous development. A. Rahman suggests concrete steps for linking scientific and technological developments to a movement for social change. Ponna Wignaraja examines the dependence of development on the transfer of external capital and technology, and formulates an alternative perspective in terms of human development, participation, and self-reliance. John W. Forge discusses the problems and needs of African countries. Ashis Nandy calls for a set of values relating to a deeper understanding of the politics of technology in its cross-national and cross-cultural contexts. Ward Morehouse discusses the need to focus debate on the underlying issues of development strategies using capital-intensive, socially inappropriate, and environmentally destructive Western technologies. (Author/KC)

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Science, Technology and the Social Order

Edited by
Ward Morehouse

SO 011 826

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CONTENTS

WARD MOREHOUSE	: Guest editorial	v–vi
JOHAN GALTUNG	: Towards a New International Technological Order	277–300
FRANCISCO R. SAGASTI	: Towards an Endogenous Scientific and Technological Development for the Third World	301–316
A. RAHMAN	: Science and Technology for a New Social Order	317–333
PONNA WIGNARAJA	: Science and Technology in a New Development Strategy	335–353
JOHN W. FORGE	: Science and Technology: The African Search for a Third Way to Development	355–369
ASHIS NANDY	: The Traditions of Technology	371–385
WARD MOREHOUSE	: Science, Technology, Autonomy, and Dependence: A Framework for International Debate	387–412
APPENDIX: DOCUMENTS	: I. The Perversion of Science and Technology: An Indictment	413–417
	II. Pugwash Guidelines for International Scientific Cooperation for Development	417–427

Alternatives IV (1978–79), v–vi

GUEST EDITORIAL

As we approach the end of this decade, we find the air thick with well over a hundred conferences, seminars, symposia, workshops and consultations, both within and outside the UN system, at international, interregional, regional and subregional (and far more at the national) levels being held in preparation for the UN Conference on Science and Technology for Development (UNCSTD) scheduled for August 1979 in Vienna.

Although UNCSTD is indeed a megaconference intended to grapple with the issue of science and technology, there are quite a few more in the offing to deal with related themes – such as the Fifth UN Conference on Trade and Development (UNCTAD V), the Third Conference on the UN Development Organization (UNIDO III), the Independent Commission on International Development Issues (Brandt Commission or, to use the acronym, ICIDI), and the UN General Assembly Special Session on the Third Development Decade, to mention some of the principal ones in 1979 and 1980.

We may be sure that we will again be treated to the kind of rhetoric made familiar in the 1970s by 'Partners in Progress', 'Riders in Spaceship Earth', 'New International Economic Order', 'Limits to Growth', etc. whose echoes in chanceries, in the corridors of the United Nations, and in university seminar rooms have not quite died yet.

While they may signify important shifts in thinking, belated and under pressure, these catch–phrases all too often spawn new myths about the international politico–economic system, obscuring the harsh and ugly reality of dominance and control and exploitation built into that system. Few go beyond rhetoric to spelling out the specific economic and political changes necessary for the realization of the kind of a less unjust social order mouthed through the rhetoric.

In this issue of ALTERNATIVES, we have sought to examine both the myth and the reality of science and technology as social forces in the modern world. We recognize the creative potential of science and technology but observe with sadness not unmixed anger how they have been perverted into instruments of power, control and exploitation. Our collective plea, voiced in the Poona statement, "The Perversion of Science and Technology: An Indictment" (reproduced

*An association of individuals and institutions throughout the globe engaged in research, education, dialogue, and action aimed at promoting a just world order embodying the values of peace, economic well–being, social justice and ecological balance.

in this issue as an appendix), is for a new perspective on science and technology so that they are dedicated to the pursuit of truth and human liberties.

The goals set by the contributors to this special issue may appear visionary. But the contributors are not politically naive. They know that achieving these goals requires a long, hard struggle for all–round social justice both between and within nations. Several of them have identified transitional strategies of practicable first steps in working towards a new approach to science and technology.

Such a new vision of the role of science and technology cannot exist apart from a new economic, social and political order. The danger of the international rhetoric about 'science and technology for development' lies precisely in this: repeated calls for more scientific research and generation of appropriate technology for the Third World can all too easily become a smoke screen to divert attention from the economic and political obstacles to the elimination of poverty and oppression and to the satisfaction of material and social needs of all peoples, especially the poor and dispossessed.

In the final analysis, what we seek is a social order that permits greater autonomy for individuals, communities and nations. If the debate at UNCSTD and the other forthcoming events on the international calendar can be kept focused on this basic issue in our present predicament as one small step toward launching a movement for greater autonomy at local, national and global levels, then the torrents of words and the never–ending perigrinations of the global problem–solvers will not have been totally wasted.

— WARD MOREHOUSE

Alternatives IV (1978–79), 277–300

TOWARDS A NEW INTERNATIONAL TECHNOLOGICAL ORDER*

Johan GALTUNG†

The main thesis of the paper is that technology is not merely a mode of production and therefore neutral; it carries within it a code of structures – economic, social, cultural, and also cognitive. The economic code that inheres in Western Technology demands that industries be capital–intensive, research–intensive, organization–intensive and labour–extensive. On the social plane, the code creates a 'centre' and a 'periphery', thus perpetuating a structure of inequality. In the cultural arena, it sees the West as entrusted by destiny with the mission of casting the rest of the world in its own mould. In the cognitive field, it sees man as the master of nature, the vertical and individualistic relations between human beings as *the* normal and natural, and history as a linear movement of progress. The transfer of Western technology is thus a structural–cultural invasion, which is not clearly seen as such parly because it is not accompanied by the West's physical presence (as in the days of colonialism), and partly because the fragmentation inherent in Western technology fragments the perception of the total picture. For techniques that create different structures to come into their own, a very clear perception of the interlocking of technology and structures is needed. Also needed is the political will to use alternative technologies as an instrument to bring about a structural change.

I. Introduction

The United Nations Conference on Science and Technology for Development (UNCSTD) is scheduled to take place in Vienna in August 1979, sixteen years after the first UN Conference on 'Science and Technology for Development'. In an epoch when the flow of history seems to be faster than before – with perhaps more eddies, waterfalls and swift currents than

*Revised version of paper presented at the World Order Models Project (WOMP) Conference, Poona (India), 2–10 July, 1978. The first draft was discussed at the seminar on 'Technology, Science and Development in the Changing International System' convened by the Research Policy Program, Lund University, Lund (Sweden), 31 May–2 June, 1978. A second version was presented at the Internationales Institut fur Umwelt und Gesellschaft, Berlin–West, 12 June, 1978. The author is indebted to the participants of all the conferences for their comments.
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7

before – much will have happened during this period. It is important to identify some of these trends – they cannot but have at least some impact on such major undertakings as UNCSTD[1] – besides the obvious environmental factors.

First, and most importantly, the power position of the Third World countries is quite different in 1979 from what it was in 1963. One might argue about the reasons: an increased self–confidence among Third World élites born of the cumulative experience since the major decolonization breakthroughs around 1960; the basic change in the terms of trade of one commodity for at least some countries (oil) around 1973–1974; the defeat of the last Western power, the United States, in Vietnam with the fall of Saigon on 30 April, 1975; and the new well–orchestrated demand for the restructuring of the world economy summarized as 'the New International Economic Order' (NIEO). Whatever the reasons, the power relations are no longer the same and will never be the same again – the relations, that is, between countries and regions, not necessarily within countries.[2]

Second, a critical awareness, a scepticism bordering on pessimism, about science has come about in the West. It was probably not so clearly felt in 1963. It is not yet a clear trend; there are ups and downs. But the general faith in science as the key to a solution of most human problems is probably undergoing a rather significant decline. The enrolment in colleges of engineering and natural science faculties might serve as a barometer here. From the rock–bottom it touched in the early 70s there was an upward trend, which subsequently flattened out and which now perhaps shows a decline. The time span, however, is too short to draw any definitive conclusion. At the philosophical–epistomological level, the attitude to science takes the form of basic criticism; at the more popular level, the form is open scepticism. The two levels interact at least to some extent.[3]

Third, there is a corresponding feeling about technology, particularly the technology developed in the West. It has not passed unnoticed that, while there is more technology in our lives than ever, major social problems do not seem to be any more tractable than before. On the contrary, it seems that the

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[1]The importance of listing the major discontinuities in thinking and practice between the two conferences was summed up by Professor E. Naraghi, Tehran; but his list of these discontinuities and mine are slightly different.

[2]For an analysis of the likely impact of the New International Economic Order, see Johan Galtung, 'Poor Countries versus Rich; Poor People versus Rich: Whom will NIEO Benefit?', *Self–Reliance and Global Interdependence* (Ottawa: CIDA, 1978); also available as *Papers*, No. 62, from the Chair in Conflict and Peace Research, University of Oslo.

[3]For analyses of the deep pessimism with regard to science in the more 'developed' regions of Europe as compared to the optimism encountered in the less developed parts and in India in a *ten*–nation study, see Ornauer, Sicinski, Wiberg, Galtung (eds.), *Images of the World in the Year 2000*, (Mouton, 1976).

main problems of modern industrialized societies have developed because of modern technology and not in spite of it: mental illness, cardio–vascular diseases and cancer – all seem to be related to stress and the last two also to pollution. Both stress and pollution are peculiar to societies built on modern technologies.[4] Whether these assertions are scientifically tenable or not is beside the point; what is important is that such assertions are increasingly believed. People continue seeking the fruits and benefits of modern technology insofar as it is labour–saving and brings comfort, but scepticism persists; there is ambivalence rather than simple enthusiasm, the honeymoon with modern technology is over. What can be called 'social pathologies' – changes in disease pattern, arrest of the increase in life expectancy, mounting criminality, all having a rate of growth between 4% and 9% per year in the major industrialized countries[5] – have been noted, although the total picture is not much spoken about. Admittedly, this can be attributed to factors other than modern technology, but it is tempting to relate it to such a key *force motrice*. Admittedly, 'technology' is used here in a broader sense, not restricting the concept to tools, skills and know–how, but also including the structures – between countries and regions, within countries, and between people – needed for a technology, whether of production or of consumption, to be operative. It may be argued that this is a trick: to relate techniques to social pathologies, an intervening variable social and cognitive structure, is interspersed. But it is not so; for techniques cannot operate except through the medium of social structures, and knowledge cannot be developed and/or imparted without a cognitive matrix capable of embedding that particular type of knowledge. Moreover, the structures serve as filters in the sense that only those techniques that are compatible with the structures will be accepted as seriously deserving of socially relevant research and development; those that run counter to the dominant structures will at best remain marginal as something for peripheral groups, and at worst be eliminated as archaic or even as dangerous.[6]

Fourth, Western industrialized countries no longer seem to be attractive as development models. They reigned supreme in the early 60s. But between the two conferences their image suffered, owing, no doubt, to the rise of China as an alternative model. It was not so much a question of whether the Chinese model was accepted or not as of the empirical existence in

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[4]For an analysis of this relationship, see Johan Galtung, *Development, Environment and Technology* (Geneva: UNCTAD, 1978), ch. 3.

[5]See Johan Galtung and Monica Wemegah, 'Overdevelopment and Alternative Ways of Life', Summary Paper from the GPID/UNU/SID Alternative Ways of Life Conference, Geneva, 21–24 April, 1978, presented at the SID North–South Roundtable, Rome, May 18–20, 1978.

[6]These points are discussed in some detail in Galtung and Wemegah (f.n. 5), ch. 5. Also see B. Persson and P. G. de Montbo, *Filters – Limits to Technological Choice.*

China of something different.The Western mode of development no longer stands out as development *per se*, but as *one* of several alternatives with its positive and negative aspects.[7] It should be remembered that to many people westernization was identical with development, which was based on economic growth and which was seen as *natural* just as body growth is seen as something that must happen to the human organism.

Is such scepticism directed against the West, both in its 'capitalist' and 'socialist' versions, a carry–over from the past animosities against powers exercising capitalist or social imperialism? Is there a feeling that it would be impossible to bridge the gap and really become like those models, either because the gap is too wide or because the methods the Western countries have used are no longer available, impossible to use or totally immoral? Or is the feeling based on the idea that it is undesirable to imitate the Western models? If the rejection is on the ground of undesirability, then it is clearly not based on much experience of the social pathologies of the Western countries; they are, by and large, unknown to the Third World. Nor can the rejection be based on hard knowledge of, or insights into, the interaction between Western science/technology and Western development patterns; for even where there is scepticism in the Third World about Western societies, enthusiasm for Western science and technology nevertheless seems to prevail.

In other words, there seems to be a split in the cognitive process which seperates Western science and technology, on the one hand, and of Western society, on the other, but with a vague notion that it might be given to the Third World to put the former to a better use without having to face the same deplorable side–effects. This is a well–known technique to avoid cognitive dissonance!

In a sense, this is an outcome of the West's ability to propagate its particular form of science and technology as universal without qualifying them with the civilizational/cultural/ethnic term 'Western' or some equivalent. As a matter of fact, the 'qualifying' adjective most in use in the West is 'modern', which, together with its implicit and explicit universalism, well expresses the Western arrogance in these matters. But it facilitates cognitive dissonance resolution by permitting non–Westerners to be against the West for any number of reasons and yet be *for* its science and technology. This goes a long way towards underpinning the thesis of universalism, making it look more symmetric, and thus side–stepping the need for recognizing that there are other technologies in this world.

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[7]For an attempt to spell out the Chinese development model in structural and cultural terms, for the period 1966–1976, see Johan Galtung and Fumiko Nishimura, *Learning From the Chinese People* (Georgi, 1977).

Curiously enough, the failure to analyse the structural aspects of technologies is characteristic also of Marxist thinking in this field – contrary to what one would have imagined; for Marxism, more than any other orientation, should sensitize analysts to the relation between techniques and structure, between means and modes of production. Alexander Szalai of the Karl Marx University of Economic Sciences in Budapest comes close to seeing the obvious fact that 'modern' technologies do reinforce class differences, without saying so:

> As a consequence of the up–to–date conditions of production and the inordinately costly investment in new high–capacity productive equipment *it became necessary* to introduce two– or three–shift and even continuous utilization of the work force (day and night turns comprising even week–ends). This was often extended to fairly great masses of workers without having previously considered and analysed what kind of changes should have been brought about in the various social institutions and services.[8]

What kind of changes? For one, 'whether workers' homes had adequate shutters, blinds, curtains to darken the bedroom in the daytime'. (Szalai:14). So, 'it became necessary'? For what? To use technology as an excuse when 'there are problems arising from the fact that husband and wife are working different shifts'? (Szalai: 14).

A good example of the shallowness of the characterization of Hungary as 'socialist' when such aspects appear as side–effects or, rather, as surprise–effects! It is also interesting that solutions are offered in terms of 'shutters', 'blinds' and 'curtains'; in other words, the technology is not challenged, only the 'side–effects' are attempted to be muffled.

This paper may well be taken to be in the tradition of the West raising a warning finger and putting up danger signs on the road on which a part of the Third World has already started travelling and on which the other is about to embark. This raises the question of the politics of the warning finger. Two probable hypotheses can and should be stated immediately: (i) Although presented as material for the enlightened self–interest of the person warned, the warning, if heeded, may also be very much in the interest of the warner; (ii) Partly for that reason, but mainly because of the paternalism involved in the warner–warned relationship, the warnings have a tendency not only to go unheeded but also to be counterproductive. They become encouragements rather than warnings.[9] To the question whether the warning against technology would tend to be one more confirmation of either or both hypotheses, the answer will probably have to be Yes to either. Nevertheless,

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[8] Alexander Szalai, 'Social Side–effects of the Introduction of New Technologies', Paper presented at the VIII World Congress of Sociology, Toronto, August 1974.

[9] This is particularly true if the warner himself does not heed in action his own warning and never seems to tire of the science and technology he warns against. Deeds always communicate better than words.

it is difficult not to issue such a warning in spite of the very poor record the West has in influencing developmental trends in the Third World.

What we have in mind goes beyond the well–known ways in which economic imperialism is operating. We are more concerned about the way in which new ideas are introduced so as to serve, deliberately or not, old purposes – for instance, such slogans as 'environment', 'basic needs', 'cultural diversity' and 'self–reliance'. All these slogans can be seen as the foundation on which development in a very genuine sense can be built. But they can also be seen from another angle. What they stand for can be translated in capsule form as follows: respect for nature; respect for the genuine needs of human beings, particularly for those most in need; respect for the fine fabric of culture; and self–reliance, i.e. developing and using one's own forces and factors, and not profiting at the expense of others. These are excellent principles indeed;[10] but the Third World can, with full right, say: 'If they are so excellent, why did you in the West not practise them? What purpose does it serve in bringing them up now except to deter the Third World from pursuing patterns of development that promise to make them strong competitors of the First and Second Worlds in the world market of goods, services and power?' Does this not apply also to the debate about technology? No doubt there are technologies that are good for building strong people. But, usually, they are not the same technologies. Why should the Third World go in only for the latter kind when the West itself did not do so in similar phases of development? Is all such talk about technology anything more than simply one more item on the list of Western efforts to prevent former colonies from becoming serious competitors?[11]

To this there is no simple answer. The allegations against the West – e.g. of hypocrisy, not practising what it preaches – are true, and they do not refer only to the past but also to the present. The people in the West who consciously, and in action, show respect for the environment, basic human needs (material and non–material), cultural diversity (particularly in respect of the ethnic minorities in the West) and for self–reliance – people to whom these four principles serve as guidelines for developing technologies – are few and marginal, at least so far. And the accusation of duplicity – taking a humanitarian stand with a clear non–humanitarian purpose – is one that

[10]Both the International Foundation for Development Alternative in Nyon, Switzerland, and the Goals, Processes and Indicators of Development Project of the United Nations University are built around such themes; all of them are also embedded in the Cocoyoc Declaration of 1974. (For one presentation of the text of that declaration, probably about ten years ahead of its time, see *Development Dialogue*, 1975.)

[11]The point can be taken further: the insistence on modesty and frugality for the Third World makes it easier for the First World to continue abusing the resources of the Third World, growing raw materials for its own industry on Third World soil, cutting down forests, mining mountains and oceans for resources, etc.

should be taken seriously. The record of the West proves the general accuracy of such an accusation. The problem, however, is that accusing the West of hypocrisy and duplicity does nothing to improve the quality of Western technology; the problem still persists! Hence, we must look into the characteristics of Western technology.

II. Some characteristics of Western technology

We refer to the technology in question as 'Western' for the very simple reason that, regardless of the roots that may be said to be universal, the technologies we are discussing have been developed mainly in the West and have spread from the West to other parts of the world with or without modifications. By 'West' we refer not so much to a geographic as to a civilizational area. But it is not important to the delimit the area in exact terms for the present purpose.[12]

Using the very felicitous phrase developed by Amulya Reddy,[13] we can see Western technology as the *carrier of a certain code* built into the structure induced by the techniques. In other words, we conceive of technology as techniques plus structure. The techniques have hardware components (tools) and software components (skills and knowledge). The structures are mainly of two kinds: economic and social, on the one hand, and cognitive (i.e. deep-lying assumptions about reality), on the other.[14] The assumption is simply this: whenever a technique is developed, deployed and/or transferred, a structure is built irrespective of whether it is a technique for production, distribution or consumption. Hence, we shall use the term technology with the understanding that technology is never 'politically neutral', and that it always carries a code which is expressed in the structure, social and/or cultural, accompanying it. Thus, the family vehicle, car, carries a message: it says something about the size of the unit that can travel in the car with comfort and, hence, something about the size of the family. The car does not only limit the family to a maximum of three children; it also indicates the structure of the family – with the parents in front and the children at the back, the father being the instrumental leader turning the wheel, the mother watching, commenting, taking care of the internal relations in the car, the boy peeping over the shoulders of the father to learn the

[12]For a more explicit statement about 'Western civilization', see Johan Galtung, Tore Heiestad and Erik Rudeng, 'On the Last 2500 Years in Western History', *The New Cambridge Modern History*, ch. 13 in Vol. 13, 1979.

[13]See Amulya Reddy's article in CERES.

[14]For details, see Johan Galtung (f.n. 5), ch. 1.

tricks, the daughter sitting behind the mother doing likewise. The car is an expression of a certain attitude to other human beings (regulated competition) and to nature (depleting and polluting nature but running away quickly from the scene).

Without going into details, let us split the code into three parts: economic, social and cultural. The economic code can be expressed in terms of factors. The formula would be that Western technology tends to be capital–intensive, research–intensive, organization–intensive and labour–extensive. As to its impact on nature, it is difficult to have a uniform view. Modern electronic industry, for instance, does not necessarily deplete 'nature', meaning raw materials for direct material or energy purposes. However, economistic reasoning in terms of abstract factors does not carry us very far. Often it makes much more sense to say 'capitalist–intensive', 'researcher–intensive', 'manager–intensive' and 'worker–extensive', referring, in other words, to human beings rather than to 'factors'. Putting it this way, one may see more clearly what Western technology is all about. It lays the basis for a mode of production that calls increasingly on the skills of capitalists (specialists in financial matters), researchers (specialists in predictive general laws) and managers/ bureaucrats/ administrators (specialists in prescriptive general laws) more than on workers. One can put it another way: Western technology leans more on the social elites than on the industrial proletariate; it may even be seen as a way in which industrial proletariate can be eliminated. One way in which this shows up is, of course, in the all too visible increase of the tertiary sector and in the decrease of the secondary sector of the Western employment structure.[15] Yet another way of saying this would be to point out that Western technology can only be put to use where there is a sufficient concentration of capital/capitalists, research/researchers and organization/managers – and this would, in general, be in the capital of a country. Given the scarcity of these factors and the necessity of concentrating them in a relatively small number of spots, the injection of Western technology inevitably tends to increase tremendously the existing inequalities.

Now for the social code. The description very often used in this connection is that Western technology is dependency–forming. This is no doubt correct. Once the technology has been implanted, an everlasting demand structure is created for spare parts, more knowledge and skills and for new technologies. This much is well known and obvious. But it is also important to realize that

[15]It should be noted that statistics dividing the 'active population' according to primary, secondary and tertiary sectors show an increase in almost all countries in recent years, but even more so in the First World countries. Moreover, since the tertiary sector covers anything from the shoeshine boy to the head of state, passing through the bureaucrats, capitalists and researchers, it is a mixed bag indeed, comprising both 'service' and 'serviced' sectors.

the same pattern is replicated, as in a system of Chinese boxes, within countries – in general, between the centre and the periphery. It should be further pointed out that the notion of 'verticality', as the general aspect of structures accompanying Western techniques which are built into the technologies, goes much further and is much richer. It is not only a case of the command positions being retained by those at the centre for their material and non–material enrichment, e.g. for the accumulation of profits by selling the work product of scientists and technicians as commodities (the price paid being referred to as fees, under the headings of patents, licences etc.) and by reserving the most important and innovating tasks for the centre because of the virtual centre monopoly on the means of intellectual production. In this process, the centre conditions the periphery by impressing its tastes on the latter and by defining what products are worth producing and consuming (i.e. the products it is possible to produce with the techniques given). The conditioning in the opposite direction is very marginal indeed. The centre constitutes an inner core, marginalizing the rest and turning them into 'factors of production' and clients who perform the roles of consumers.

It is also worth noting that Western techniques of production and consumption tend to be fragmenting in the sense that they can be carried on without much interaction or mutual help between the producer and the consumer. Workers in a factory may be tied together with the visible and invisible ties of that particular form of organization, but they are not necessarily in direct interaction of mutual dependence. The same applies to consumption. For instance, two persons watching TV are tied together by that medium, but they are not necessarily watching together in the sense of interacting. Further, Western technology tends to be segmenting: people participate in it with only a small part of their personality, often referred to as specialization or compartmentalization. Thus, Western technology tends to drive wedges between and even within people. This much is often written about and commented on. But what is even more important is that there is a total picture, a total pattern, which on other occasions I have referred to as the 'alpha-structure'.[16] My thesis is that all this is built into Western technology.

It may be objected that this type of analysis is too structuralistic and that it should be accompanied by an analysis in more concrete terms: Who are actually the people at the centre of this structure? It seems fair to say that they are the same people we pointed to in the preceding analysis of the economic code carried by Western technology, i.e. the specialists in finance, research and administration. In general terms, these are the key categories

[16]See footnote 15.

in what is loosely referred to as the 'tertiary sector'; they occupy the upper rungs of the social ladder inside that sector.

The basic point in this approach to technology can now be formulated: It is not that technology happens to induce structures of this type by chance; it is, rather, that the structure produces, filters out and accepts only the techniques that will be accompanied by such structures, thereby reinforcing the structures themselves.[17] Any technology that demands less in terms of finance, research and administration will constitute a threat to specific groups of people. If, in addition, it is more horizontal in the sense of inducing less difference between the centre and the periphery, is less conditioning of the periphery, less marginalizing, fragmenting and segmenting, they fear that the general power of the centre over the periphery will be reduced.

Today, it looks as if China is an important case for those who want to study the structural aspects of technologies. If the Cultural Revolution was about anything, it was exactly about building production patterns that would be less vertical. The people's communes were a particularly important instrument in this regard; they are less dependent on finance, research and administration, and they use techniques that can be more integrative, inducing more togetherness, more general participation, more mutual conditioning and, indeed, bringing about more equity within and between communes and between units inside the communes. But this could not possibly take place except at the expense of the power of certain groups: the state capitalists (the private capitalists having been eliminated as a class at an earlier stage), the researchers/professionals/intellectuals, the bureaucrats – and to this one might add the top military people and the top party people as two particular élites closely related to the other three.[18]

It can be guessed that the five groups of élites did not like to see their power base eroded, regardless of whether this was done with or without violence, with or without personal humiliation (in the event, probably

[17]See Daniel Thery, In 'L' industrialisation: imitation ou innovation', *Revue 2000*, No. 34, 1976, pp. 33–38. Daniel Thery gives eight examples of alternative technologies, among them those of biogas, the bamboo tubewell and imaginative uses of bicycles. For all these there are indications of local creativity the moment there is no longer any dependency on local bureaucrats, capitalists and/or researchers, '. . . ces faits démentent les théses communement répandues sur l'inertie des petits fermiers et leur résistance au progrés téchnique (p. 36). What is quite clear, however, is how exactly the élites resist such initiatives. To take another example: Cain, Afshar, Norton and Mohammed–Reza Daraie point out in their article 'Traditional Cooling Systems in the Third World' (*The Ecologist*, Vol. 6 no. 2, pp. 60–64) how effective ancient cooling systems such as the porous water jar (the 'Maziara') are, keeping water cool throughout the day even when the outside temperature fluctuates between 19°C and 36°C. But what gains would there be for the financier–researcher – administrator combine in a system as simple as that? Or for the oil companies which make profit on producing the electricity that is used in mechanical refrigeration?

[18]For more details, see Johan Galtung (f.n. 7), last chapter 'China After Mao'.

without much violence but with much personal humiliation). As far as one can judge, they did not wait long after the death of Mao Tse–tung to hit back, and the rest of the story since his death is to a large extent the story of basic technological change, meaning (re–) introduction of techniques that can more properly be described as Western in the sense of inducing the particular economic and social profiles delineated so far. In other words, the struggle – in fact, the fight – about which technology to use is essentially a political struggle about power, about the steepness of the centre–periphery gradient of the society, and about who shall be in the centre and who on the periphery.

The blindness of one particular social science, 'economics', to such aspects of production, distribution and consumption should make one venture the hypothesis that the major social function of that science is exactly to mask the real relationships between people. Marxism did much to lift that veil, but not enough. There was and is in Marxism far too much concentration on ownership patterns – a very special and juridical aspect, as Marx himself points out. There is not enough about exactly what should be the strong point in Marxist analysis: the relation, often contradictory, between means and modes of production (Marxism, incidentally, also has relatively little to say about consumption). In a sense Marxists are worse off than others; for they are led to believe that a change in ownership patterns is not only a necessary but also a *sufficient* condition for more basic changes to take place.

We come now to the cultural or civilizational codes. The ideas which generated Western technology constitute a certain cosmology, an implicit way of viewing the world in general and society in particular.[19] Without going into details, five components of Western cosmology that are of significance may be mentioned: (i) the tendency to see geographical space in centre–periphery terms with the West as the centre; (ii) the tendency to see time as linked with progress, increasing in a linear, and preferably in an exponential manner; (iii) the tendency to think of reality in terms of units abstracted from the whole, of which they are parts, and relate them to each other causally and mechanically so that changes in one will imply changes in the other; (iv) the tendency to see vertical and individualistic relations between human beings as the normal and the natural; and (v) the tendency to see man as the master of nature, with unlimited rights. These tendencies are not always explicitly formulated as open ideologies; they go deep, constituting the basis for defining something as normal and natural and something else as abnormal and unnatural.

[19]For a fascinating analysis in a historical perspective, see Lynn White, Jr., 'Technology Assessment from the Stance of a Medieval Historian', *Technological Forecasting and Social Change*, 1974, pp. 359–369.

Western technologies are taken as normal and natural insofar as they are compatible with the above tendencies. They become normal and natural if there is dependency on a Western centre, if they produce more and more, if they are based on analytic rather than holistic insights, and if they engender man–over–man and man–over–nature relationships. Technologies which fall short of these criteria, or which oppose these criteria, are seen as strange, quaint, 'romantic' (a very important term in the vocabulary of those who defend Western technologies), and they are rejected.[20]

The total picture, thus, is one of transfer of technology as structural and cultural invasion, an invasion possibly more insidious than colonialism and neo–colonialism, because such an invasion is not always accompanied by a physical Western presence; often not even the élites with allegiance to the West are to be found anywhere. The invasion thus becomes entirely acceptable to the élites who reject the West in all its aspects – except its technology. It is these élites that will meet in late August 1979 in Vienna for the UNCSTD.[21] No doubt UN conferences can serve to articulate problems; but our simple thesis is that they can articulate only those problems over which there is sufficient dissent in the conference room itself. As for the UNCSTD (roughly speaking, a conference of national delegations, i.e. élites interested in preserving the internal power structures cemented by the technological structures described earlier), there will be articulation about the terms of transfer, not about the nature of what is transferred.[22]

We shall round off the picture with the environmental factors. The accusation against Western technology is that it tends both to pollute and to deplete

[20]The debate over energy forms for the future, now that the Western plunder of the Middle East is coming to an end, is a good example here. From the point of view of the three élites mentioned earlier, nuclear energy systems stand out as ideal; for they are impossible without a high–level supply of heavy bureaucracy, capital and research. However, it must not be presented that way; so the decision to build the future around nuclear energy has to come as a 'rational' decision. It is made to appear rational by a biased choice of competing systems (in fact only one, coal), and by a limited spectrum of criteria (e.g. economic efficiency).

[21]Volker Rittberger discusses UN conferences in an excellent paper for the Lund Seminar: 'The New International Order and United Nations Conference Politics: Science and Technology for Development as an Issue Area'.

[22]For a remarkable effort to tackle this problem and build more genuine articulation into the UNCSTD exercise, see the series of *The Lund Letter on Science, Technology and Basic Human Needs* (Notes on Preparations for the 1979 United Nations Conference on Science and Technology for Development), starting with No. 1, July 1977 (issued about every three months). Together with Stefan Dedijer's, *The Failure of the 1978 UN Conference on Science, Technology and Development*, Offprint Series No. 2, Research Policy Program (University of Lund), they give us one side of the sociology of a conference. The other side of UNCSTD, one can assume, is that of a vain secretariat, unable to accept that type of criticism and advice, trying to fend it off by characterizing the critics as marginal. And yet, it is safe to assume that future historians of UNCSTD and similar conferences will say: 'If only they had managed to overcome hurt vanity and had paid more attention to such critics!'.

non–renewable resources. It also tends to have a very deep impact on the level of maturity of eco–systems, both at the micro and the macro levels.[23]

How is it possible not to see all this? The reason is very simple. It is that the fragmentation induced by Western technology tends to fragment the total image of Western technology. Some emphasize the environmental aspects, some only look at the economic factors, particularly the capital costs; others look at the social factors, and some others still are primarily concerned with the compatibilities or incompatibilities between Western technology and endogenous cultures. Only very rarely are these fragments put together to produce a relatively total picture of the type attempted in the preceding pages. But even if such a total image becomes more visible, it would still not constitute a sufficient basis for mobilization against Western technology. It may lead to consciousness–formation, but not necessarily to political action.

This is so because there is a second factor at work. It can be argued that even if everything said so far is true, it still does not add up to the total picture. The total picture must include the good features of Western technology. If that technology did not have any good aspects, the West itself would have given up that technology (unless, of course, one assumes that Western people are all fools or masochists). In short, there must be something to Western technology since it is so vigorously embraced, in spite of all the noises emanating from the citadels of the West itself saying that it is not good. Perhaps the noise–makers are like a millionaire telling the destitute that 'money is not everything in this world', or like the over–educated double Ph.D. telling the illiterate: 'Believe me, I am sure you are a wiser person than I am.'

III. Will Western technology have the same positive effects in the Third World as in the West?

The position taken in this paper is certainly not that Western technology is all bad or that it cannot bring any benefits whatever to the Third World. We concede that there are highly capital–intensive projects that, when properly evaluated, can have rather positive effects. One example of this is the communication and transportation facilities between peripheral points in a Third World country (or in any country for that matter), although transportation/communication facilities between the capital and the periphery have more mixed consequences as they tend to be the media through which the centre exercises more control and also resorts to more

[23] See Galtung (f.n. 4), ch. 3.

exploitation of the periphery. Then there are health schemes (particularly in the field of preventive medicine) that are based on capital, research and organization; these have ensured that life expectancy at the age of four is no longer too different in the developed and the developing countries.[24]

Labour-saving devices do eliminate excessively heavy, dirty, degrading and monotonous work, except that monotony is then re-introduced by the way industrialized modes of production tend to organize work. Western technology also generally provides comfort by way of ensuring protection of the human body and psyche against the less pleasant aspects of nature. It is possible to argue that this has led to overdevelopment, at least for some segments of the population in Western countries, inasmuch as they are over-protected from all types of heavy work (including the 'heavy work' of walking); over-protected but, because of the distance from nature thus created, in some ways, more vulnerable. It can be counter-argued that, since there is an interval between underdevelopment of most Third World countries and the overdevelopment in some parts of Western countries, the validity of the above argument is problematic (except for certain élites, usually located in Third World capitals where the same phenomenon may already be present).

Much more important, however, is a different argument. It is generally assumed today that the high living standard in the First World has been achieved and sustained at the expense of the Third World. It has also been possible for the First World to have a high level of equality because it has exported its own periphery to the Third World, which today takes the concrete form of export of jobs to the Third World, thereby cutting labour costs by something like 90%.[25] Patterns of exploitation no longer possible inside the First World countries can be perpetrated in the Third World through a new international division of labour.[26]

To repeat this trick with a technology that is inherently periphery-forming, the Third World needs to have a fourth world to exploit. It can be said that this is already being done by the Third World élites in the capitals, using the rest of the country as the fourth world. But this raises the question who the fourth-worlders can exploit. The answer is *Nobody*. There

[24] The difference between the life expectancies at birth is, of course, high, as may be gathered from the general development literature. The infants and small children are the major victims of underdevelopment in that sense.

[25] The best work available on this topic is Otto Kreye, Jürgen Heinrichs and Folker Fröbel, *Die Neue Internationale Arbeitsteilung* (Hamburg: rororo aktuell, 1977).

[26] There are two major methods: the import of foreign workers to carry out menial jobs no longer wanted by local workers (e.g. garbage collection), and the export of jobs to places where workers, less mobilized politically and willing to accept much lower wages, are easily available for such jobs.

is no extra fifth world around; the process runs out of worlds – unless some exploitable celestial body is discovered.

Secondly, although the material conditions of Third World workers may not be too different from those of the First World workers as described by Marx in the last century, there are some important differences. Technology has 'progressed' further. The transition from electro-mechanical to electronic industry has made the vertical division of labour, the conditioning, the marginalization, the fragmentation and segmentation even more pronounced, thus making the worker even more of a robot.[27] This raises the question whether the worker will not soon be replaced by robots simply because robots are less troublesome and offer better returns. It should also be remembered that the Third World, the global countryside, is also being increasingly exposed to the same type of industrialization process, producing commodities for First World markets rather than goods for subsistence.

Let us reformulate these arguments. Western technology is inherently periphery–forming. It does deliver goods and services, an astounding variety of them, but at a cost: it is hard on people and hard on nature. The techniques always induce externalities, largely positive for the centre insofar as creativity is demanded from the few, but primarily negative for the periphery because of the sacrifices demanded from the many and from nature. To the Western way of running the world, this is natural (normal), and so the world is, or should be, like that. Colonialism was one expression of it, capitalism is another, Western technology is yet another. To internalize the positive and externalize the negative factors is what the system is about. From pushing the negative externalities on their own masses, the Western centres seem to be increasingly successful in pushing them onto the Third World.

This leads to the all–important conclusion that this state of affairs will not change if the same technologies are put to use inside the Third World. The externalities will still be highly unequally distributed. It is rather unlikely that the First World will accept the negative externalities by doing jobs for the Third World, contributing only raw nature and underpaid workers and being relegated to the periphery, and thus committing cultural suicide. So, some Third World countries, their masses and nature will have to carry the burden. Because of the built–in structure, the technology itself will *force* the stronger Third World countries to start exploiting the weaker ones, and the élites to exploit the masses and overtax nature. This is a necessary condition for that technology to be operative. It is not that this is a mere possibility;

[27] Kreye *et al*. make this one of the key conditions for the new international division of labour, the other being the lower transportation costs making it economical to produce far away from the markets (although a local market close to the production site is no objection).

it is already happening.[28] Thus, the adoption of Western technologies by the Third World (i) will not help the masses in these countries, (ii) will lead to a situation where the masses cannot be exploited further, and (iii) put the Third World at the end of the road where there is nobody left to exploit.

IV. Some criteria for the selection of technologies[29]

Given the type of critique of Western technology presented above, what should be the criteria that can and should be used in order to minimize, or completely avoid, the more deleterious aspects of that technology? What are the questions that should be asked of any technology, the guide–lines that should steer the work of scientists and technicians concerned with real development? One such proposal is tabulated below:

(1) BASIC NEEDS SATISFACTION:
- does it directly or indirectly (over a short period) contribute to the satisfaction of such basic needs as food, clothes, shelter, health, education, transportation/communication?
- does it produce goods and/or services accessible to those most in need?

(2) FACTOR DEVELOPMENT:
- does it use local factors optimally over time?
- does it generate employment?
- does it develop medium and high–level skills, engineering and R&D capabilities and use them for the purposes of further technological development?
- does it save/generate capital?

[28] The Third World countries to watch are those capable of investing abroad, such as Mexico, Brazil, Nigeria, Saudi Arabia, Iran, India, and the four mini–Japans, viz. South Korea, Taiwan, Hong Kong and Singapore. At the moment, the sub–imperialist model is probably no longer applicable; these countries may start exploiting other Third World countries not on behalf of the classical imperial countries (the US, the UK, Japan etc.) but on behalf of themselves, although probably not if this exploitation is at odds with the interests of the 'mother' countries.

[29] This section is based on a presentation made at a UNEP seminar on selection of technology, Nairobi, September 1976. I am indebted to other participants in the seminar, particularly to Amulya Reddy, its able chairman, and to Surendra Patel of the UNCTAD Division for Transfer of Technology.

— does it save/generate raw materials including energy?
— does it generate more appropriate technologies?
— does it increase the capacity to produce on a sustained cumulative basis over time?

(3) STRUCTURAL DEVELOPMENT:
— does it reduce dependence and promote self-reliance (autonomy combined with selective exchange on an equitable and solidarity basis and with mass participation) at the local/national/regional levels, enabling the society to follow its own path of development?
— does it reduce inequalities
  (a) between occupational, ethnic, sex and age groups?
  (b) between rural and urban communities? and
  (c) between (groups of) countries, especially in the field of scientific and technological capabilities?

(4) CULTURAL COMPATIBILITY:
— does it make use of, and build on, endogenous technical traditions?
— does it blend with/enhance valuable elements and patterns in the local/national/regional culture?

(5) HUMAN ENRICHMENT
— does it lead to creative involvement on a mass basis by being accessible, comprehensible and flexible?
— does it liberate human beings from boring, degrading, excessively heavy or dirty work?

(6) ECOLOGICAL BALANCE
— does it minimize depletion and pollution by using renewable resources through built-in waste minimization, recycling and/or re-use and blend better with existing eco-cycles?

— does it improve the material and man–made environment by providing for a higher level of complexity or diversity of the eco–system, achieving balance?

In the list of criteria proposed in the Table, the broad headings 'economic', 'social' and 'environmental' are used. It is in the nature of such lists to generate more controversy than consensus, potentially leading to a fruitful process of adding to, subtracting from and modifying the items. Such a process is a part of consciousness–formation. The present list derives its rationale from the current thinking and practice in the field of eco–development.[30] Development is seen as 'development of human beings, not of things'; it is interpreted as the satisfaction of material and non–material needs. The prefix 'eco–' stands, not only for countering depletion and pollution, but also for building a stronger environment. These are the broad criteria which have to be taken into account in arriving at decisions not only for the selection of technologies, but also for the processes that generate these technologies. It needs to be emphasized that the weight assigned to each criterion, or a combination of criteria, must be determined in each individual case with as wide a participation as possible of persons directly involved in implementing them or affected by their implementation.

The purpose of laying down criteria for the selection and development of technologies is to broaden the base for decision–making in this field. This is crucial for any progress in the field of eco–development. The relative weight given to these criteria will vary from place to place and over time, but by making the criteria explicit we have ensured that at least some consideration is given to each. There is a very important qualitative difference between, say, ignoring completely the extent to which a technology builds self–reliance and considering the factor of self–reliance by giving it low or high weight but conceding that the technology chosen does not meet the criterion. In the first case, the decision–making agenda remains closed in that direction; in the latter case, the item is at least on the agenda, forcing a consideration of the issue. In so doing, the criteria may potentially serve to increase the level of joint economic/social/environmental consciousness, not only among policy–makers, but also among scientists, engineers and technicians,[31] and, above all, in the population at large. There is a general

[30]For a good introduction to the topic of eco–development, in English, see the special issue on Eco–development, edited by Bernhard Glaeser, of *Vierteljahresberichte, Probleme der Entwicklungsländer*, No. 70, 1977, from the Forschungsinstitut der Friedrich–Ebert Stiftung.
[31]For an effort to explore ethical problems confronting any scientist from the point of view of basic needs, see Johan Galtung, 'Science and Neo–colonialism' in *Papers on Methodology* (Copenhagen: Ejlers, 1978), ch. 5.

need for increased technological consciousness in the populations of most countries. This will generate demands on those who deliver the technologies; popular inventiveness itself will make them accountable in terms of such criteria.

An adequate and generally acceptable methodology of selection, based on criteria such as these, does not exist today. One reason for this may be that excessive specialization and professionalization have led to such diverse approaches in economic, social and environmental sciences that we do not even possess a common language adequate for comparisons across disciplinary borders, leave alone a common unit of measurement. There is need for a general development in these disciplines and need also for the growth of transdisciplinary approaches warning against any methodology that tends to exclude criteria not yet qualified, possibly because they are intrinsically non-quantifiable (this is particularly true of some of the social criteria). Whatever can be quantified should be quantified; for whatever cannot be quantified, 'rules of thumb' can often be developed – e.g. the judgement of a qualified group of those affected one way or the other by the decision as to whether the technology is 'positive', 'indifferent/unclear', or 'negative' in its consequences along that particular dimension. Whether quantitative or qualitative, the net outcome of such considerations would be a profile for any given technology. It should be in favour of simultaneous rather than sequential evaluation of the profile lest sequential decision-making should (i) knock out, in the first filtering process, technologies which, in their totality, may have highly redeeming characteristics; and (ii) play up to narrow specialization, disciplinary or otherwise, instead of fostering the type of broad overview and approach that simultaneous evaluation would tend to foster. In such an evaluation, there would still be room for making a criterion an absolute condition (in the sense that if it is not met the technology in question is out), but only after giving the technology a chance by looking at the total profile.

Criteria such as these should not be interpreted in a passive, static way or used as yardsticks for the selection of existing technologies (from a set of alternatives). They must be applied in an active, dynamic way, as a heuristic method leading to the development of new technologies. Few technologies today will meet all the criteria, but this should encourage the quest for ever more appropriate and environmentally sound technologies, not merely to a trade-off between criteria. Since the social and environmental criteria are the ones that have received the least attention so far, the concrete consequence of adopting such lists of criteria as general guide-lines will probably be to generate new technologies rather than to evaluate already existing ones, provided the criteria are used in a constructive spirit, opening new sources of inspiration in technological innovation.

Even with a much higher level of consciousness and inventiveness, including popular participation, it is obvious that there will always be technologies which do not meet all the criteria. The criteria relating to local self–reliance, human enrichment and cultural compatibility may often best be met by technologies related to relatively small–scale industries and more limited economic cycles. In such settings, environmental criteria may also be easily satisfied. Many of the economic criteria may possibly be best met by technologies associated with large–scale industries and extended economic cycles, sometimes operating at the national, sometimes at the regional and sometimes even at the global levels. Hence, the criteria should be seen as a guide for a better mix of more appropriate technologies operating at the various levels, in different and in the same sectors of goods and services (e.g. in the fields of food production, or medical care). In some countries, this should lead to a strengthening of technologies at the local level; in others, it should strengthen other levels. What such a mix means is that there is no all–out rejection of 'Western' technology or all–out acceptance of 'traditional' technologies. The criteria, when used constructively, can do much to modify and develop further 'Western' and 'traditional' technologies alike and, moreover, generate new technologies that cannot be placed in either category. In so doing, it will be recognized that the unit of selection and modification/development is not the technology itself as narrowly conceived with its hardware and software components. The total structure and process related to it become the unit of selection. Consequently, the selection process becomes a part of the general social dialogue that is the very stuff of the human liberation processes.

Without one–sidedly extolling the virtues of the local and the shortcomings of the higher levels of production/consumption, it must be pointed out that the thrust of the total approach would be to strengthen the local level. Predictably, this will lead to resistance from groups with a vested interest in the higher levels. Such groups include not only those engaged in centralized decision–making and resource–control (including the control over capital), but also scientists and researchers in general. Science tends to be universalistic, searching for general solutions; central administration tends to look for nationally standardized solutions; and capitalistically run enterprises tend to be both expanding and centralizing. All this leads to a considerable harmony of interest between these three groups, not only at the national, but also at the regional and global levels (including intergovernmental agencies).[32] Modes of retaining and redirecting scientific research – to mention but one activity – to make it more relevant for, and sensitive to, the local level and to

[32]Indeed, the harmony between all these actors, or limited, disciplined disharmony, is an essential precondition for all these organizations to function.

local participation would therefore be an important ingredient in any action programme devoted to the objective expressed in the criteria. This means blending scientists and villagers in ways unknown today.[33]

V. Some proposals for joint action

Given this kind of situation where, on the one hand, there is a well developed technology with many built–in dangers and, on the other, there is a quite explicit list of wishes, desiderata, but not many technologies that meet them, what can be done? More particularly, what can be done in a joint cooperative manner, involving both the North and the South, the First, the Second, and the Third Worlds, and preferably in a multilateral, perhaps a UN, setting? The following are five broadly phrased proposals in that direction:

First, the basis of technology assessment should be broadened. In addition to the economic and environmental criteria, we should also add more explicitly the social and cultural dimensions. Assessments should be made public, including warnings. If it is possible to reduce smoking in industrialized countries, at least among middle–aged males, by means of a campaign where prospective buyers of tobacco products are warned that they may be 'dangerous to your health', it should also be possible to reduce some of the abuses of technologies by issuing warnings to the effect that they may be dangerous to individual as well as social 'health'. It would be interesting to see what conclusions joint North–South commissions working on such problems might arrive at. It is quite clear, though, from past experience that the problem is not whether the composition of the commission is international, but whether it is sufficiently interdisciplinary, whether it includes a sufficient number of perspectives on technology, and also whether it includes people who are not intellectuals and who, for that reason, do not have our *deformation professionelle*.

Second, there is the task of developing together technologies that meet the requirements better – for instance, those listed in the foregoing Table. In doing so, there should be a very good basis for North–South cooperation on an equal footing. The South can contribute deep insights into traditional technology; the North can provide what has been developed recently and what is very quickly being developed in the field of alternative technology.

[33] Yash Pal, in his contribution to the 25th Pugwash Conference, Madras, 13–19 January, 1976, 'Alternative Development Strategies for Developing Countries', makes a strong plea for scientists and technicians to work with the people in the villages, and also reminds us that 'appropriate science and technology is not necessarily archaic science and technology'.

Thus, an economic profile that might emerge would include the type of technologies that are nature–extensive, capital–extensive, labour–intensive, research–intensive and organization–extensive.[34] In other words, the major inputs would be labour and research, work and ingenuity. It may well be that recent advances in new ways of producing foodstuffs, based on a much broader utilization of natural eco–systems, would fall into this category.

One objection to this may be that research would probably be carried out in the North and work executed in the South. The problem, then, would be to find ways of transcending that type of contradiction. One place where this can probably be done might be in communes established in northern Europe, typically staffed by highly educated intellectuals with considerable research training and skills, but also very willing to engage in manual work. This would be another example of how structures may produce techniques if the consciousness and the political will are present. When these two important factors are not present, the techniques will induce structures, and human beings will be conditioned by those structures.

Third, to develop a new mix if different types of technologies, whether they are referred to as Western/non–Western, alpha/beta or whatever. This is very much a field in search of not only practice but also of theory. How much and what should be given to Western technology to produce, how much and what to other types? Again, this is a field where North–South cooperation can be on an equal footing. As long as that 'cooperation' is about conditions of transfer of Western technology, it is obvious who has the upper hand. But in the political wish for more equitable relations, North–South is an expression of structure. That structure should itself serve to regulate the composition of the mix so that more equal relations can be obtained. For this to happen, much political skill is needed. It will not be easy to produce the necessary willingness to let the opponents of 'modern' technology in the North, and in the South as well, have as much say as the very vociferous proponents already command.

Fourth, the possibility of more transfer of technology the other way around, from the South to the North, needs to be explored. The argument in favour of this would not, in general, be in terms of the transfer of traditional technology of the South. Such technology would usually be as unsuited to the North as Western technology is to the South.[35] The only condition under which such transfer would be possible would be the reverse of the condition

[34] I am indebted to Bernhard Glaeser for sensitizing me to this combination, particularly important in the field of locally self–reliant rural technologies with an initial high research input (such as new developments in the biomass field, in the coupling of algae dams to biomass converters, etc.).

[35] Thus, much traditional technology, e.g. in the field of medicine, is so interwoven with religion (indeed, the effort to separate the two analytically is in itself very Western) that Westerners would probably feel rather alienated.

that has obtained in the world; this means 500 years of domination of the South over the North preparing the ground. This condition not obtaining, what is of interest today is more openness in the North to consider new ways of developing 'mixes'. One interesting example of this is how Japan, a country, which one century ago would have been classified as belonging to the 'Third World', was able to build a buffer around Western technology, encasing it in a social structure somewhat different from the Western one.[36] Today there is transfer of technology from the North to the South and the beginnings of technical cooperation between the South and South (TCDC). It is high time some patterns of transfer of technology from the South to the North emerged.

Fifth, what about channels of transfer of technology other than those most prevalent today, or about a dialogue on technology? When we say transfer 'from the North to the South', it is actually a non–valid metaphor; in fact, it is a transfer from certain groups in the cities of the North to certain groups in the cities of the South. It is urban–urban cooperation, which leads one to ask the question what rural–rural cooperation might look like. What would happen if a more direct dialogue and cooperation were to take place between rural communites – for instance, communities which try to become more self–reliant, whether they are located in southern Tanzania or nothern Norway?[37] Today they may articulate demands or needs imposed upon them, but the channel through which a dialogue and possible cooperation can take place would be the negotiating élites drawn mainly from the two capitals concerned, in bilateral or multilateral settings. Needless to say, the world communication structure is made in such a way as to steer cooperation that way, away from those that potentially might benefit most from direct contact.

VI. Conclusion

The general thesis of this paper can now be stated in one sentence: Techniques are accompanied by structures, and these structures eventually decide which techniques will be seriously researched, developed and deployed. The

[36] In sociological terms, the Japanese structure combines the universalism of the Western (and not only the Western) approach with the diffuseness of the traditional approaches in patterns in which workers and functionaries are treated very 'objectively', but with a wide spectrum of their persons taken into account, unlike in the West where it is very narrow.

[37] To our Knowledge, the closest approach in the world today to this kind of idea is the UNU project directed by Chandra Soysa from the Marga Institute in Colombo, Sri Lanka, 'Sharing of Traditional Technology'.

structures steer the techniques once they have become sufficiently well rooted. Techniques that induce very different structures will tend to be rejected, left undeveloped, or marginalized as things to be indulged in by small, peripheral groups. For these techniques to come to the forefront and dominate the social picture, a highly conscious attitude to the interplay between techniques and structures is needed. Also needed is the political will to change the structures and use alternative techniques as one instrument in this structural change. That political will is not easily brought into action when everything seems to proceed relatively smoothly. It is absent when the negative effects of the technologies can, by and large, be pushed onto others within and outside the country and even to other regions.

From this it would follow that it is mainly during crises that a major change of techniques will take place. In other words, it will come about when the dominant structure is sufficiently weak. Thus, there has never been such a lively debate about alternative technologies in the West as during the oil crisis.[38] If that type of a crisis situation were to return, it is likely that the movement towards alternative technologies will be given even further momentum, not only in terms of new technical innovations, but also in terms of social practice. Thus, we may very well end up with the following situation: As the crisis broadens and deepens in the West,[39] the search for alternative technologies and for better mixes will be intensified. This may possibly lead to much more felicitous combinations in the West. At the same time, the wave of Western technology will have continued unabated into the Third World, enriching the few and impoverishing the many, materially as well as non-materially. So, once more, the West may end up with the better part of the deal.

[38] A personal experience: living in a high-rise appartment with absolutely no other heating possibilities than oil-fueled burners in the basement, it stimulates thinking when I read the janitor's note on the bulletin board to the effect that the temperature will be lowered by one degree per day (late fall 1973, Oslo, and a very cold winter too).

[39] See Galtung (f.n. 2) and Galtung, Heiestad and Rudeng (f.n. 12).

Alternatives IV (1978–79), 301–316.

TOWARDS AN ENDOGENOUS SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT FOR THE THIRD WORLD*

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Starting from certain premises on the role of science and technology in development, this essay examines five components of a strategy for endogenous scientific and technological (S&T) development, suggesting concerete measures and possible lines of action. The last section offers some remarks on the way these measures, and the principles behind them, may be examined and dealt with in the context of the 1979 United Nations Conference on Science and Technology for Development (UNCSTD) and other subsequent international meetings on similar or related issues.

Premises

During the last three decades, modern science and technology have become increasingly important in international relations, particularly in the relations between the highly industrialized and the less developed countries (LDCs). Technological progress has been credited with contributing more than any other factor to the economic growth of the industrialized nations, both in the East and in the West, and the technological content of manufactured goods has become a major determinant of world trade patterns.

There is a noticeable shift towards the use of modern science–based technology by the highly industrialized nations as a way of retaining their influence, and even control, over the productive and social activities of Third World countries. A few highly industrialized countries, and the transnational corporations that are based in them, currently control the generation of, and access to, modern science–based technology. Furthermore, the economies of these countries generate a surplus of food and manufactured

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goods which they supply to underdeveloped countries in return for raw materials and energy. Under exceptional circumstances, some Third World countries may have sufficient food or capital; but, as was shown on several occasions (and, recently, after the oil price increases which induced a massive transfer of financial resources to the OPEC countries but without affecting their technological dependence), the highly industrialized countries are the only ones capable of fully linking a self-sustaining base of scientific activities with the evolution of productive and social techniques.

For the purpose of this essay, we shall distinguish between two types of countries: those in which the evolution of scientific activities led directly, or was clearly linked with, advances in production techniques, and those in which the knowledge-generating activity was not related in any significant way to productive activities. We shall refer to the first as countries with an endogenous scientific and technological base, and to the second as countries with an exogenous scientific and technological base. Considering that this division can be seen to be reflected in the current division between the highly industrialized, or developed, countries and the Third World, or underdeveloped countries, one of the central problems in designing a strategy for autonomous development is that of linking the scientific knowledge-generating activity with the technological bases of both modern and traditional productive activities.

A significant degree of autonomous and self-reliant development can only be achieved if a country acquires its own scientific and technological capacity; that is, if the process of generating production technologies based on scientific knowledge is endogenized. Nevertheless, unlike what happened with the highly industrialized countries that now have an endogenous scientific and technological base, the traditional technological base must not be discarded. On the contrary, it must be recovered and fully integrated with the development of scientific activity and the evolution of modern production techniques.[1]

From this perspective, one of the key problems is how to organically relate the conduct of scientific activities with the technological capabilities associated with both modern and traditional productive activities. This implies the fusion of the scientific knowledge-generating current with the evolution of the technological bases of modern production, and with a systematic and selective restoration of the traditional technological base. These three elements must be combined around the problem areas of critical importance to the country's development, leading to a gradual replacement of the exogenous technological base. It should be recognized, though, that this is a long

[1]These concepts are presented here only in summary form; for an elaboration, see Francisco R. Sagasti, *Technology, Planning and Self-Reliant Development: A Latin American View* (New York: Praeger Publishers, 1979,) chs. 1 and 10 (in press).

process and can be accomplished only over time. It should also be recognized that for a variety of reasons this would not be possible for a great majority of Third World countries on their own, and that it is essential that they cooperate with each other. Thus, in regard to the endogenization process, the imperative of cooperation among Third World countries must always be kept in mind.[2]

In this process of linking the three elements that form the scientific and technological axis of an autonomous development strategy, it is essential to preserve the nation's cultural and social identity, particularly because it appears increasingly difficult – indeed, almost impossible – for most Third World nations to adopt the current consumer–oriented and wasteful pattern of economic activity that characterizes the highly industrialized countries of the West. This is possible only if development styles and strategies quite different from those now prevailing in the highly industrialized countries are adopted. The magnitude of the task of preserving the cultural identity so as to reflect the deepest aspirations of a people, while at the same time providing an adequate framework for the formulation of alternative development styles, must not be underestimated, particularly in view of the overwhelming pressures of Western science and technology, the continuous cultural aggression of the mass communication media, the invasion of products from a highly industrialized consumption–oriented civilization, and the transfer of cultural values and patterns through a variety of channels ranging from consumer habits to educational systems.[3] However, it is not possible for a Third World country to conceive, much less put into effect, an endogenization of the scientific and technological revolution oriented towards a just and equitable style of development unless the traits making up its cultural and social identity are identified, affirmed and preserved.

To give an example, the Pre–Hispanic Andean civilizations maintained an egalitarian tradition, adopted diverse forms of management of their economy and ecology, and evolved a very complex political and social structure, which together enabled the region's resources to be used appropriately (without irretrievably depleting them) for the benefit of the majority of population.[4] These traditional Andean ways of relating with the environment and using a spectrum of available technologies suited to a wide variety of local ecological conditions were almost completely abandoned following

[2] See Sagasti (f.n. 1), ch. 9.

[3] See M. Nerfin (ed.), *Towards Another Development* (Uppasala, Dag Hammarskjöld Foundation, 1977); and D. Goulet, *The Uncertain Promise: Value Conflicts in Technology Transfer* (Washington, D.C.: Overseas Development Council, 1977).

[4] See John Murra, *Formaciones Economicas y Politicas del Mundo Andino* (Lima: Instituto de Estudios Peruanos, 1975), particularly ch. 3; R. Ravines, *Technologia Andina* (Lima: IEP/ITINTEC, 1978); and V. Patino, *Historia de la Actividad Agropecuaria en America Equinoccial* (Cali: Imprenta Departmental, 1965).

the Spanish conquest, although some traces still survive and can be revived and linked to scientific activities. This also happened to the traditional technological bases of India and other Asian and African countries.

Admittedly, no Third World country can escape the responsibility of taking action internally and, where possible, in cooperation with others to endogenize science and technology. But it must be recognized that an alternative scientific and technological model of development is not possible without a new international scientific and technological order any more than an alternative economic model of development is possible without a new international economic order. The present inequitable scientific and technological order is a reflection of the enormous differences between the S&T endowment of countries with an endogenous scientific and technological base (highly industrialized countries) and the S&T endowment of countries with an exogenous base (Third World countries). These differences are the result of the same historical processes that gave rise to the phenomenon of underdevelopment; they have led to the control of the great majority of modern production technologies by a small group of highly industrialized countries and transnational corporations. While these two pursue their objectives on the domestic front to relate the generation of scientific knowledge to the modern and traditional technological bases, Third World countries must make efforts to change the present distribution of scientific and technological capability at the international level and break the high degree of control exercised by a small number of highly industrialized countries and transnational corporations.

We shall now examine some of the components of a possible strategy for endogenous S&T development in the Third World. In doing so, those aspects that are related to technology transfer will be left aside, not because they are unimportant, but, rather, because they have already received considerable attention, and because several experiments are under way in the international arena to improve the process of technology transfer (e.g. UNCTAD's activities with regard to the code of conduct for technology transfer and the reform of the international patent system).

Elements of an endogenous scientific and technological strategy

We shall briefly examine five components of a strategy for endogenous scientific and technological development: (i) autonomy in decision-making in matters of science and technology; (ii) choice of the problem areas where the process of endogenization of the S&T revolution should be pursued; (iii) redistribution of the world scientific and technological effort; (iv) granting

of privileged access of Third World countries to the acquisition of technologies to satisfy human needs; and (v) cooperation among Third World countries so that the UNCSTD, UNCTAD V, UNIDO III, the UN Special Session on the Third Development Decade may have a significant impact.[5]

Autonomous decision–making. It is necessary to recover and enhance decision–making autonomy in matters of science and technology in order to reach the first level of technological self–reliance.[6] Autonomy means the freedom to define the need for S&T knowledge; to identify existing options to satisfy them; to determine priorities for the development of the local S&T capacity, focusing on areas where the endogenization of the S&T revolution may be initiated and sustained; and to determine the best way to acquire, incorporate and absorb imported technology.

Decision–making autonomy is closely linked to national self–control or independence, i.e. the freedom to set national objectives and choose the means for attaining them. This implies a political act of affirmation and the ability to sustain it – neutralizing internal and external interferences – for as long as may be necessary to consolidate the socio–economic transformation, thus reaching toward an alternative style of development in which science and technology can realize their potential for contribution to human welfare. This act of affirmation must include, among other things, measures that will make it possible to control investments, modify consumer habits, guide social and productive activities, and determine the use of natural resources. These measures are fundamental to following a self–reliant policy in the area of science and technology. The patterns of investment, consumption, production, space management, and resource use determine the nature of the demand for scientific and technological knowledge. Therefore, it is not possible to achieve decision–making autonomy in science and technology without pursuing broader policies for autonomous decision–making in other areas of the development strategy.

Endogenization of the S&T revolution. It is necessary to identify an initial group of problem areas where the generation of scientific knowledge, the expansion of the modern technological basis, and the systematic recovery of the traditional technological basis can all be integrated in such a way as would endogenize the scientific and technological revolution.

As an initial approximation, we shall propose five criteria for identifying

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[5]For a more detailed discussion of national policies for S&T development, see *Science and Technology for Development: The Problem of Policy Design and Implementation* (Ottawa: International Development Research Centre, 1978).

[6]See Sagasti (f.n. 1), ch. 9.

the problem areas where efforts should be concentrated.[7] The first criterion derives from the need to secure a critical mass to undertake scientific activities, and this should be examined from the quantitative, qualitative, and interfacial points of view. Taking the quantitative aspect, the question is to ensure the availability of human, physical, and financial resources above the minimum level to generate scientific knowledge of direct interest to the problem area. From the qualitative point of view, the resources available should have the characteristics that make them suitable for the selected activity (trained and experienced scientists, equipment satisfying certain specifications, etc.). From the interfacial point of view, it is necessary to gather a qualitative and quantitative base of resources, not only in the scientific field of immediate interest for the problem area, but also in those neighbouring fields which interact strongly with what constitutes the main axis, because advances in science arise frequently from the combination of knowledge generated in adjoining fields.

The second criterion derives from the fact that problem areas in which the merger of scientific advances with traditional and modern technological capabilities is to be promoted must be country-specific. They should be determined after taking into account the social and historical context as well as the availability of natural and human resources. The identification of problem areas should be country-specific also in the sense of being closely linked to the style of development chosen and designed.

The third criterion stems from the possible societal impact of the fusion of the three currents. The idea is to ensure the largest possible multiplier effect of the integration of science with modern and traditional technological capabilities so as to facilitate their integration with other problem areas, as well as to diffuse throughout the society the values and view-points related to the organization of the scientific and technological base.

The fourth criterion is the possibility of exercising world leadership, so that the country will become an internationally recognized centre of scientific excellence in a particular problem area. This can be achieved through concentration of efforts, which will eventually pave the way for a more balanced exchange of scientific knowledge and technologies with other countries.

The last criterion is based on the possibility of obtaining concrete results in a reasonable period of time, expressed in terms of producing and utilizing technologies related to scientific findings and of linking scientific activity with traditional technological capacilities. Moreover, the merger of the three currents in a specific problem area should serve as a starting point to undertake the integration process in other areas, thus generating a

[7] See F. Sagasti (f.n. 1), ch. 10.

cumulative sequence which would facilitate the growth of an endogenous scientific and technological base.

It is clear that the strategy outlined here must be complemented by the development of a capacity for regulating technology imports, primarily because it would take a long time for the endogenization process to acquire a magnitude significant enough to make it self-sustaining. This underlines the need to increase the country's bargaining power, to be well informed about the scientific advances, and the technologies derived from them, in other parts of the world, and to improve the technology-absorption capacity of the productive sector. At the same time, and given all types of limitations faced by the underdeveloped countries, it will also be necessary to promote international collaboration agreements, especially among underdeveloped countries facing similar problems.[8]

Redistribution of the world S&T effort. The third component of an endogenous S&T development strategy refers to the redistribution of the world scientific and technological effort aimed at changing the present concentration of scientific and technological activities in the highly industrialized countries, (some 95% of the total world S&T expenditures). Three lines of action could and should be pursued in this regard, viz. generating and channeling additional funds for scientific and technological activities in the Third World, using human resources that have emigrated from the Third World to the highly industrialized countries; and reorienting S&T activities in the industrialized world to the needs of the Third World.

In addition to increases in governmental and private financial allocations, it is absolutely necessary to design mechanisms to generate additional funds for S&T activities in the Third World if the present maldistribution of global S&T effort is to be significantly altered. In the first place, it is possible – through legislation adopted at the national level and without any need for international agreement – to compel industrial enterprises to assign a proportion of their gross profits to S&T activities, as ITINTEC has been doing in Peru for several years.[9] With such a measure, about an addional $ 200 million would be available each year for science and technology in Latin America (see Table 1 below). Another way of obtaining additional funds would be to compel enterprises which pay royalties for licensing agreements to allocate an equal sum to scientific and technological

[8]On this matter, see F. Sagasti (f.n. 1), ch. 9; and F. Sagasti and M. Guerrero, *El Desarrollo Cientifico y Tecnologico de America Latina* (Buenos Aires, BID/INTAL, 1974), ch. 3.
[9]See F. Sagasti (f.n. 1), ch. 7; I Flit, *La investigacion tecnologica y el desarrollo industrial* (Lima: ITINTEC, 1977); and G. Flores, 'Contribucion del ITINTEC al desarrollo de una capacidad tecnologica nacional' in ITINTEC: *La investigacion tecnologica industrial en el Peru* (Lima, 1975).

Table 1

Gross profits of manufacturing industries in Latin America and possible size of the 2% science and technology fund

	(millions of US dollars – 1975*)				
	(1)	(2)	(3)	(4)†	(5)
	Gross Industrial Product (GIP)	Manufacturing % of GIP	Manufacturing share of GIP	30% of (3) as Gross Profits	2% of (4) for S&T
Argentina	1·624	32·2	0·524	157·2	3·1
Brazil	30·188	25·6	7·828	2348·4	47·0
Colombia	4·957	18·7	0·927	278·1	5·6
Costa Rica	0·905	16·6	0·150	45·0	0·9
México	41·944	24·1	10 068	3030·4	60·4
Péru	6·284	18·7	1·145	343·5	6·9
Republica Dominicana	2·119	17·6	0·372	111·6	2·2
TOTAL	88·021	23·9	21·014	6304·2	126·1
TOTAL of All Latin America	138·076	24·2	33·416	10 024·8	200·5

*At 1970 prices.

†The percentage of gross profits was obtained for Colombia from 1967 to 1973, and it remained around 30% on an average. The same percentage was assumed for other Latin American countries.

Source: CIID '*Indicadores Economicos y Sociales 1977*', based on ECLA figures.

activities, as stipulated by the Technology Promotion Law in the Republic of Korea.[10] Considering only royalty payments to the United States of America, this would provide an annual amount in excess of $ 200 million for S&T activities in Latin America.[11] Another way to generate additional funds would be to assign and set aside a certain percentage of the loans provided by government agencies to enterprises – such as the 0·25% allocated by the Argentinian Development Bank – to S&T.[12] This mechanism could also be extended to international financial agencies.

Other mechanisms to generate additional funds for S&T activities, but ones that require agreements with international agencies and government organizations of highly industrialized countries, would involve the allocation

[10]See KunMo Chung, *Technology and Industrial Development in Korea*, Final Report (Korean STPI Project, 1977).

[11]For the royalties paid by less developed countries to the USA, see *Science and Public Policy* 2, 6, June 1975, p. 251.

[12]A.Ozlak, M. Cavarozzi, and S. Sonino, *El INTI y el Desarrollo Industrial de Argentina*, Report of the Argentinian STPI Project, 1976.

of a certain percentage of foreign aid given to Third World countries for the development of local scientific and technological capacities, such as the Canadian policy of allocating 5% of total foreign aid for this purpose through the International Development Research Centre. As mentioned above, the allocation of a certain percentage of international development financing for S&T, considering both governmental and multilateral agencies, could also provide an additional source of funds at the international level.

Furthermore, it is also possible to set aside a certain percentage of direct foreign investment for the promotion of scientific and technological activities in the Third World through agreements with the governments or national corporations of host countries. For example, the agreement signed between the Peruvian government and the Swedish automobile firm Volvo provides for the establishment of a research, testing and training centre. It should be stressed that the various measures proposed above would not imply a significant burden on the loans, investments, royalty payments, or gross profits, and that in all cases their application is viable.

Finally, a compensation mechanism, linked to the surpluses in international trade with certain highly industrialized countries, could be considered as a basis for setting up an international fund for S&T development in the Third World. A certain percentage of the balance of trade in manufactured products that incorporate technology (chemicals, machinery, transport equipment, manufactures etc.) in favor of the industrialized countries could be devoted to the development of technological capacity in those countries that have unfavorable balances. As shown in Table 2 below, if only 0·25% of this surplus were allocated for this purpose, it would generate about $ 58 million yearly for Latin America in payments from the United States of America, the European Economic Community, and Japan. The scheme proposed to establish the fund could consider increasing percentages as targets to be met as time passes; as soon as trade advantages based on technological superiority diminish, the fund could be reduced automatically. As an initial step, such a mechanism could be established among Third World countries, with the relatively more industrialized contributing to the least developed ones, even though the amounts channeled to the fund are likely to be rather small.

These mechanisms can make it possible, with slight changes in existing practices, to increase significantly the flow of funds for scientific and technological activities in the Third World, thus initiating a gradual process of redistribution of the world scientific and technological effort. Of course there remains a variety of organizational problems before these proposals can be put in practice; but these do not constitute serious difficulties if the political determination to act is present.

Table 2
International balance of trade in manufactures and size of proposed S&T fund based on trade surplus

(millions of US dollars – 1975)

	Exports to Latin America		Imports from Latin America		Balance against Latin America		0·25% of balance for S&T	
	All Countries	LAFTA	All Countries	LAFTA	All Countries	LAFTA	All Countries	LAFTA
(5) Chemical products:								
USA	2·324	1·899	0·423	0·145	1·901	1·754	4·7	4·4
European Economic Community (EEC)	1.801	1·336	0·266	0·134	1·535	1·202	3·8	3·0
Japan	0·207	0·157	0·38	0·23	0·169	0·134	0·4	0·3
(7) Machinery & transport equipment:								
USA	7·490	6·379	0·417	0·357	7·073	6·022	17·7	15·0
EEC	5·433	4·227	0·126	0·103	5·307	4·124	13·3	10·3
Japan	2·540	1·095	0·49	0·48	2·491	1·047	6·2	2·6
(6+8) Other manufacturing:								
USA	2·954	2·122	1·350	1·133	1·604	0·989	4·0	2·5
EEC	2·776	1·922	1·166	1·115	1·610	0·807	4·0	2·0
Japan	1·795	1·348	0·156	0·152	1·639	1·196	4·1	3·0
Total manufacturing: (5+7+6+8)†								
USA	12·768	10·400	2·190	1·635	10·578	8·765	26·4	21·9
EEC	10·010	7·485	1·558	1·352	8·452	6·133	21·1	15·3
Japan	4·542	2·600	0·243	0·223	4·299	2·377	10·7	5·9
						Total for R&D	58·2	43·1

*LAFTA: Latin American Free Trade Association.
†Using the International Uniform Trade Classification.

Source: *UN Monthly Bulletin of Statistic*, February and May 1977.

Regarding the use of qualified scientists, engineers, and technical personnel from the Third World working in the highly industrialized countries, both in governments and private enterprises, it would be possible to design a sabbatical year system through which the firm or government of the highly

industrialized country would pay one year of salary every seventh year for the professional to work in his country of origin or in another Third World country. This would add but a small amount to the cost of each professional, and travelling and relocation expenses could be covered by the country in which the professional is going to work or by some international organization. This proposal will not involve excessive costs and will enable some Third World countries with very limited qualified scientists and engineers to use the services of experts in certain fields of interest to the country's development.

The reorientation of the scientific and technological effort in highly industrialized countries towards the problems of Third World countries, it should be emphasized, would not by itself lead to an endogenous and self-reliant S&T development. It may even give rise to greater dependency, particularly if private firms and transnational corporations in the industrialized world were to benefit from the results of these S&T activities behind the cover of offering 'new' and 'more appropriate' technical responses to Third World problems. Nevertheless, particularly when activities are financed by government agencies, it would be possible to use the human resources, equipment, materials, and financial potential of the industrialized countries to help in solving some of the problems of the Third World in close collaboration with scientists and technicians from the less developed countries. For example, a certain percentage of the allocation of research financing agencies could be devoted to research into the problems of the underdeveloped countries, but with research proposals being jointly selected and evaluated by professionals and scientists from the industrialized countries and Third World.

Another way of reorienting the scientific and technological capacity of the highly industrialized countries towards Third World problems would be to place their scientific equipment, material, laboratories, and other facilities at the disposal of scientists from underdeveloped countries, so that they might carry out research. For example, some universitary laboratories are used relatively little during vacation months, and these could be used by Third World research teams.

Clearly, no single measure to redistribute the world scientific and technological effort will change the present concentration of scientific and technological activities in the short term. Even if all these measures were put into effect simultaneously, the present situation would be altered only marginally in the medium term, but their cumulative impact could be substantial in the long term. Even if the proposed measures are seen only as a marginal change at the world level, they may have a considerable impact on particular countries and may constitute an initial step that has the advantage of being viable.

Privileged access to technology. The fourth element of an endogenous S&T development strategy consists in providing privileged access to technologies required to satisfy minimum material and social needs in Third World countries. Privileged access does not imply only the possibility of buying technology from the industrialized world, but, rather, the right to acquire it at nominal or no cost; it also implies the receiving of technical help and assistance to use, absorb and improve on the technology acquired. This is equivalent to ensuring the social control of technology that would enable such needs as food, housing, health, and education to be met, particularly in the poorest countries of the Third World.

If this privileged access is to be obtained by the least developed countries, a series of changes in the international order, especially in the system of patents, is necessary. It cannot be expected that those holding patent rights under the existing international legal system will give them up willingly through acts of altruism. However, there is neither moral nor economic justification to continue receiving royalties for the use of technologies which, in many cases, were amortized more than a quarter of a century ago and are still under private control due to a series of stratagems allowed by the patent system (such as patenting slight variations on critical components of a given process, so that control over the technology in question is maintained long after the original patents were supposed to have expired).

It would therefore be necessary to establish an international agency, or assign the function to an existing agency or consortium of government agencies, for acquiring control over these technologies, either through cession or expropriation. If the governments of the highly industrialized countries are willing to take action in this regard, it would be possible to begin with the rather large number of patents that are in the hands of governmental organizations.

It will even then not be enough to ensure that these technologies become freely available; it will also be necessary to support the less developed countries that lack the capacity to absorb and improve on them. For this reason, this international agency or consortium of government agencies should also provide the means to facilitate the absorption of these technologies to satisfy human needs, educate local personnel, foster their adaptation to local conditions, and establish the foundations for their continuous improvement.

Cooperation among Third World countries. The fifth element of strategy for endogenous S&T development involves the design of new forms of cooperation among Third World countries. One mechanism for organizing such cooperation, without interfering with existing international arrangements and without imposing a significant financial burden on the less developed

countries, would be to establish an international association with a large membership of underdeveloped countries from all regions in the world. Membership would entail sharing in the support of a small central staff, whose main task would be to identify, structure and launch S&T projects to be undertaken by institutions and individuals from the member–countries. The projects could involve research, technology adaptation, negotiation with technology suppliers, training, information exchange, and any other activities linked to the pursuit of technological self–reliance. Not every country would participate in each project, although it would be expected that all countries take part in at least one project. The association could be established through a broad multilateral agreement or letter of intent signed by all member–countries, and the projects would be launched through specific multilateral agreements among the countries interested in them.

The central staff would consult with the relevant institutions in the member–countries in order to determine priorities for the identification and design of research projects. It is envisaged that a small group of highly qualified professionals, nominated for a fixed term (e.g. 5 years), would constitute the central staff, although they could be assisted by consultants working for short periods. The members of the central staff would not engage in research as their main activity, although they could participate actively in some specific research projects. To avoid establishing a permanent international bureaucracy, they should not be reappointed after the expiry of their term. Finances for the central staff may be met by relatively small contributions from all member–countries, with the possible complement of funds from international organizations and donor agencies. This way any drain on foreign exchange resources could be avoided. It is clear that the central staff would be located in a Third World country. A supervisory board elected by the member–countries would oversee the functions of the central staff.

Specific projects would be carried out in selected institutions of the participating countries in a decentralized way. The projects would be temporary, and a coordinating committee, consisting of one representative from each participating country, would be responsible for their execution. If found necessary, there may also be a project coordinator accountable to the committee. In this way, no permanent organizational structure would be created around the projects, and at a given moment there would be several projects under way, others in gestation, and still others that would have been completed. The organizational arrangements would depend on the nature and scope of the problems to be tackled; for some may require the existence of a central laboratory, while others may be handled in a completely decentralized way. Flexibility should be maintained in this regard.

In addition to the cooperation schemes among Third World countries,

new mechanisms must be designed for cooperation between the highly industrialized and the underdeveloped countries. In this regard, the Canadian and Swedish initiatives merit particular attention. The Canadian International Development Research Centre (IDRC), for example, is an organization financed by the Canadian government, with policies determined by an autonomous Board of Governors, half of whom are non–Canadians. Its main objective is to develop the scientific and technological capabilities in underdeveloped regions, through financing research programs in a wide variety of areas.[13] The Swedish initiative with similar purposes is known as SAREC (Swedish Agency for Research Cooperation with Developing Countries). Comparable initiatives by other industrialized countries should be encouraged as a way of contributing directly towards the promotion of science and technology in the Third World.

If an organization for cooperation among Third World countries were created with the characteristics outlined above, it would be possible to establish a constructive dialogue with organizations from industrialized countries similar to the Canadian IDRC and the Swedish SAREC so that research networks might be established among Third World countries with the support of various institutions in the industrialized countries.

Some suggestions for forthcoming international conferences

The premises together with the possible lines of action outlined in this essay suggest that the process of S&T development for Third World countries is a long and difficult one, and that it must be initiated as soon as possible. The various international conferences and other global events – such as the Brandt Commission on Development Issues on the Society for International Development's North–South Roundtable now in progress or forthcoming over the next two years – present an opportunity to focus world attention on these issues.

The preparations for UNCSTD have encountered some difficulties, and there are serious doubts whether it will be possible to reach a general agreement on concrete steps and measures for making effective the potential contribution of science and technology to development.[14] Hence the

[13]See L. Berlinguet, 'Views on the Transfer of Technology Based on Recent Programmes in the Third World', a paper presented at the OECD seminar on 'Science and Technology Policies and Activities of Member Governments to meet the needs of Developing Countries', Paris, April 10–13, 1978; and D. Hopper, *Research Policy; Eleven Issues* (Ottawa, IDRC, 1973).

[14]For an account of these difficulties, see the various issues of the *Lund Letter* published by the Research Policy Program of Lund University, Sweden.

importance of enlarging the arena of debate to include other forthcoming events. These various conferences, commissions and study groups provide an international forum where issues can be discussed, basic principles agreed upon, and programs of action explored.

In the light of the ideas and suggestions put forward in the preceding sections, there are two types of possible outcomes of these conferences. First, there are the general declarations of principle, endorsed by consensus, which would give moral support to future efforts to reorient science and technology towards development needs. Second, there are the recommendations to establish programs of action that could give content to the declarations.

Among the general principles, major emphasis should be put on the propositions that endogenization of the scientific and technological revolution is necessary to escape the condition of underdevelopment; that a new international scientific and technological order is necessary to support the efforts towards the establishment of a new international economic order, and that it is impossible to have the latter without the former; that the redistribution of the world scientific and technological effort is a necessary condition for a more equitable and just international order; that technologies for the satisfaction of minimum needs are the common heritage of mankind; and that the least developed countries should be given privileged access to them.

Among the concrete measures that may be agreed upon as part of a program of action, there are two that should be emphasized: the creation of mechanisms to redistribute the world scientific and technological effort, and the establishment of new forms of cooperation among Third World countries and between them and the highly industrialized countries.

In the preceding section we have suggested a variety of measures to redistribute the world scientific and technological effort, all of which are politically and economically viable and have precedents for their establishment. What is required is their internationalization and legitimization by the various forthcoming international events.[15] Also, the establishment of a mechanism for Third World cooperation in science and technology along the lines suggested in this essay could emerge as a concrete recommendation; for there are several precedents at the regional level showing its viability. Finally, the creation of institutions similar to the Canadian International Development Research Centre and the Swedish SAREC in the

[15]In particular, the mechanism to establish a fund linked to trade surpluses has begun to gain acceptance, and after it was proposed in May 1978 in Caracas, the member-countries of the Andean Pact and of the Economic Commission for Latin America have agreed in principle to suggest that it be considered at UNCSTD.

industrialized countries could be recommended to increase and channel cooperation for S&T development in the Third World.

As we approach the last two decades of this century, UNCSTD and the other international conferences on North–South relations offer a great opportunity for defining the form and content of future international efforts to achieve a more equitable and just world order. Modern science and technology are indispensable components of any development efforts in the last decades of the twentieth century, and the principles and mechanisms set forth here should provide the framework for making truly effective the potential contribution of science and technology to human betterment.

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SCIENCE AND TECHNOLOGY FOR A NEW SOCIAL ORDER*

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The paper points out some of the existing limitations of science, in terms of its isolation, highly specialized nature of knowledge and its language, its present linkages and their consequences. It points out the nature of technology, particularly with regard to control of resources and generation and preservation of inequalities, in addition to inefficient machines and systems and pollution problems. It also points out the unequal relationship between the developing and advanced countries and the political, economic and technological pressures exerted on the former by the latter to play a satellitic role. The paper suggests that major transformations could be effected when scientific and technological developments could be linked to a movement of social change. It goes on to suggest concrete steps which could be taken to effect that.

The heated debates in councils and committees are a means of making money by the capitalists. Whenever the slave tends to awaken from his sleep, the magic of the ruler puts him to sleep again.
—Iqbal (1877–1938), Philosopher and Urdu poet

A crowded international agenda

As we approach the final two decades of the twentieth century, the international agenda is crowded with events focused on the central issue of our time – the gap between the advanced and the developing countries. UNCTAD V, UNIDO III, the General Assembly Special Session on the Third Development Decade, the 1979 UN Conference on Science and

*The views expressed in the paper are those of the author and not necessarily those of the organization where he works.

No references have been given because the list would have been very long and might have distracted attention from the theme.

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47

Technology for Development (UNCSTD) – all represent efforts of the UN system, under political pressure from the developing countries, to do something about the gap that has continued to grow, leading to economic subservience and erosion of political sovereignty of the newly independent countries.

All these events, UNCSTD most explicitly, deal in one way or another with the role of science and technology in social change within and among countries. In view of the importance of this subject in an age when scientific enterprise has become perverted into an anti–social and destructive pursuit and technology is fast becoming the principal instrument of international domination, one would have hoped that the exercises in global problem–solving would address themselves to the twin underlying questions of the social purpose of science and technology and of how these pervasive forces in the modern world can be set on a constructive course. But if preparations for UNCSTD are any guide, these questions are not likely to be faced.

UNCSTD preparations at the national level are, by and large, preoccupied with searching for solutions within the existing framework along the familiar beaten track. National papers for UNCSTD consist predominantly of oft–repeated statements of national goals and objectives for strengthening scientific and technological capabilities to be able to attack immediate problems facing the developing countries in particular areas, such as health, food, energy, rural development, etc. – areas in which research could be directed to meet certain specific requirements. The statements also deal with the role of international agencies and multinational corporations, as well as some of the technical problems, such as transfer of technology, choice of labour–intensive or capital–intensive technologies, and management of R&D systems.

These problems and issues have been discussed over the years in numerous international conferences, organized by national agencies and academic institutions, different UN agencies and other international bodies, but their efforts have produced little except a voluminous literature. Each of the different UN agencies – ILO, UNESCO, WHO, FAO, UNCTAD, UNIDO, UNEP, WIPO, and others – appears to be competing with the others in promoting ideas which have developed as a part of their sectoral interests or as theories of people who represent a dominant group in the organization.

Another conference of this nature, if it is not to be a tiresome repetition of what has already been said dozens of times, should examine the problems of development in the context of the role of science and technology in social change and their impact on society. Critical analyses should be made of some basic issues, such as the purpose of science and the nature and pattern of its

development, technological innovation, the social linkages of science and technology, and their impact on society in general, and on different sectors of population and different countries in particular. Also needed is a searching examination of what really has been accomplished by past national and international exercises and with what social consequences.

Unless such critical reviews and analyses are made, it will be difficult to know the shortcomings or the advantages of the policies followed and programmes implemented in the past. Many of the earlier programmes had well-defined objectives; they were sound scientifically and technically; and considerable resources in terms of aid and expertise went into them. Yet it appears that the goals and objectives were not achieved, or only partially achieved, and new problems requiring more resources were generated.

The basic assumption in the name UNCSTD itself is that science and technology should be utilized for development. The concept of development itself has been left vague. To many countries, development means becoming in the future what industrialized countries are today. The point of view on which this paper is based is that the role of science and technology in development should be directed toward reduction of inequalities between the advanced countries and the developing countries and between various sections of population within a country; and, in doing so, development should make the natural and social environment more harmonious, without seriously endangering the future.

Underlying problems generated by the growth of science

The accumulation of scientific achievements over the centuries and the rapid development of science in recent decades have led to an exponential increase in new knowledge in the twentieth century. This knowledge is stored and communicated in a language which only the initiated can comprehend. The concepts and models based on the knowledge acquired are similarly comprehensible only to a few. As a result, its implications are understood only by a discrete group – the scientific élite and the industrialists and political leaders, who are the present-day patrons of science. They are able to use it for their own purposes and control its further development by providing investment in those areas which serve their purposes rather than meet the needs of the people.

This situation is analogus to the one which prevailed when the alphabet was discovered. Knowledge accumulated and preserved through the written work became the property of a priestly class which kept it to itself in order to use it as an instrument of control. This led to the division of society into those

who worked – the mass of the people – and those who lived off the labour of others – priests, soldiers and landowners. Thus was laid the foundation of an unequal social order.

Today, again, we have come to witness a combination of keepers of knowledge (the scientists and technologists) and controllers of knowledge (the industrialists, politicians, and militarists). Together they form the ruling élite and are responsible for perpetrating a society based on inequality. They are responsible for diverting resources from productive channels to meet human needs to those leading to ever greater exploitation of the people and to increasing production of instruments of warfare and destruction.

The compartmentalization of knowledge has led to an over–emphasis on technological problem–solving without sufficient attention to socio–economic and cultural needs. Consequently, many scientific and technological solutions cannot be utilized or, when utilized, generate other social problems. Further, this compartmentalization has led to the neglect of those factors, primarily social and cultural, which cannot be quantified. The dominance of science in the contemporary world has resulted in an over–emphasis on quantitative methods and techniques used by natural sciences. Under the guise of quantification and objectivity, human factors are ignored, and solutions allegedly aimed at helping the people have led to greater problems for them.

Scientific research has now become a very expensive industry. Indeed, it has become so expensive that in some areas even the richest nations cannot afford it by themselves. Priorities for investment in research are established, and, in the absence of a broad public debate and consensus on the social purposes of this investment, resources are allocated by politicians or industrialists in terms of their objectives. One manifestation of this situation is the huge concentration of resources on R&D for technologies of mass destruction and repression.

Each area of science has human and social implications. Until very recently, these consequences were largely ignored. Current developments in scientific fields, such as biology, have now made us realize that many of the ethical, moral and other questions can no longer be overlooked. Science has not yet developed any methodology or technique to analyse such issues, let alone a satisfactory method for their resolution. Consequently, what is good or bad, moral or immoral, social or anti–social, is left to the judgement of politicians and industrialists, who have the economic and political power to implement their decisions and therefore count, or to philosophers and reformers who are powerless and therefore do not count.

Scientific training has come to emphasize specialized knowledge. The result of this training is that students of science have little appreciation of, or insight into, the purposes of science, its growth, and its links with social,

moral and ethical problems. With basic questions about the need for more research in certain areas of science or the social, cultural or environmental assessment of science–based technologies becoming more urgent and insistant, scientists are found to be ill–equipped to tackle them. This has led to an escapist attitude among some scientists who take refuge in their laboratories, ignoring questions about the purposes of research and its moral or social implications.

It is worth reminding ourselves that ancient and medieval science was concerned with moral purposes. Contemporary scientists argue, in contrast, that science is socially neutral and amoral, leaving the purposes of science and utilization of results of research to those who provide funds for research. This enables scientists to lay the blame for misuse of science on the sponsors of research, even though the scientists are active players in the game.

The preceding discussion underscores the need for taking a hard look at the purposes of science and for the examination of its ethical and moral dimensions. There is also a need for a more integrative approach within science which takes into account the interrelationahips among the specialized branches of science. The natural sciences must also be more effectively linked to the social sciences and the cultural values and social purposes. In order to achieve this integration, major changes in the education of scientists will be needed and the isolation of science from its social and cultural environment broken down.

Underlying problems generated by recent technological change

The pace and direction of technological change in recent decades has raised another set of underlying social, environmental, and cultural issues. Here are five such issues which should be at the centre of discussion at the forthcoming international conferences.

First, contemporary technology, in contrast with ancient and medieval technology, has emphasized the use of non–renewable resources, not only in the production of machines, but also for those products where renewable materials could have been utilized. The accelerating use of non–renewable resource is rapidly advancing the day when the world's supply will be exhausted, particularly of those resources which are used for generation of energy.

Second, the demand for energy has been growing at an alarming rate. Many newer technologies in different industries, including agriculture, require much more energy than traditional methods, both for mining and processing raw materials as well as for making goods. The utilization of

energy has also become very wasteful, both because of the low efficiency of machines and because of the inefficiency of technology systems of which these machines are an integral part. Much energy in the form of gas and steam is let off in the atmosphere. Further, huge high–energy urban centres have grown up, requiring vast amounts of energy to provide amenities such as cooling and heating, transportation, lighting systems, and other facilities.

Third, many recently developed technologies and the industries based on them have led to widespread environmental pollution, chemical or thermal, affecting soil and water as well as the atmosphere. Radioactivity is the most hazardous of such pollution.

Fourth, many technologies now require a huge volume of production to achieve economies of scale, leading to greater and greater concentration of production, with production units becoming larger and larger. These units are primarily located in urban centres and, besides huge energy consumption in transporting raw materials and finished products, cause other problems connected with urbanization.

Finally, priority is being given to the development of technologies that meet a limited set of purposes, mostly of profit to those who control industry. The effect of these technologies on environment and society has been more often than not ignored. The sectoral approach of each industry and the overriding consideration of making profits has resulted in increasing the social costs of technology which are really an indirect subsidy to the particular industry. Low priority, because of limited or no profitability, is given to the development of technologies to solve social problems or meet basic human needs.

The technologies generated have increasingly resulted in creating a class of people who command considerable resources, and therefore power, in society. The industrialists, by virtue of developing and utilizing newer and ever more profitable technologies, are able to create resources which, when utilized in a particular manner or area of economy, determine the direction of social change. With profit as the primary motivation, investment has gone into areas likely to yield most profit instead of areas of greatest social need. In fact, in some areas like health or food, basic social needs have been perverted to suit the interests of the industry and to increase profits, with a resulting growth in human suffering.

Investment in war technologies has continued to grow exponentially. The total expenditure on, and the number of scientists and technologists employed in, research on technologies for destruction and repression appear to exceed those dealing with research for constructive social purposes. The direct expenditure is only part of the cost. Excessive use of non–renewable resources, energy, and creative scientific and technical capabilities are among the added social costs. The role of the military–industrial complex in

determining national priorities and policies in international affairs has come to be decisive.

Major corporations which control technologies influence, both directly and indirectly, the flow of knowledge and its utilization, on the one hand, and socio–economic and political policies, on the other. These corporations are guided by their own interests in increasing profits and achieving ever greater control of resources, unconcerned with social or moral considerations. The use of technology as an instrument of international domination is increasing through the control of technologies for the utilization of natural resources and for the manufacture of synthetic alternatives to primary commodities on which many developing countries depend for foreign exchange earnings.

The most obvious social consequence of technological change in recent decades has been to increase inequality and exploitation through the control of resources and the types of goods produced. Then the damage to the human and social environment caused by recently developed technologies is now reaching a scale that will, unless serious effort is made to check it, make the situation irremediable. The excessive preoccupation with war technologies is part of a dominant social system dedicated to the generation and perpetuation of inequality and exploitation. This system has been able to sustain itself only through the acquisition of natural resources and materials from the developing countries obtained at very low prices.

We urgently need a social philosophy of innovation to determine the priorities in technological change. Should priority in developing technology be for profit or for meeting social needs? If for the latter, is priority to be given to the demands of individuals or the people as a whole? Should priority be given to technology that perpetuates inequalities or to one that promotes equality? Methods have to be devised to illuminate the social and moral issues involved and to assess technological choices from such perspectives as energy conservation, use of non–renewable resources, and impact on the human and social environment. Unless this is done, technological decisions will continue to be taken to serve sectoral needs and the interests of those in power.

Social and cultural values in contemporary society

Why have these unhealthy results of recent scientific growth and technological change been allowed to grow to such alarming dimensions and remained uncorrected for so long? Why were methods that have given such spectacular results in science and technology not applied to overcome these defects?

Would these methods have been applicable if they had been tried? Or are there more fundamental obstacles? The search for answers to these questions leads us to the realm of social and cultural values of contemporary society, which have over–emphasized the role both of the individual and of profit.

The over–emphasis on the individual meant that products were made to meet his needs in housing, transportation, health services, and the like instead of working out social solutions to serve the needs of the people as a whole. As a result of this approach, the majority of the people were left out of the benefits which they would otherwise have reaped as a result of development of science and technology. Disparity and inequality continued to grow with each advance of science and each development of new technology, and a number of larger problems and social costs were overlooked, such as the following:

(i) *Waste.* Waste has become an essential feature of contemporary society, both in the production system and in the utilization of goods. It is estimated that in providing individual transportation from house to place of work (when the former is built far away from the latter as a mark of status), one country wastes more petroleum than the total consumption of all Third World countries. A rough estimate of waste generated by households in industrialized countries is of the order of 400 million tons a year, comprising 40% paper products, 20% textiles, 15% food, 15% metals and glass, and 10% plastic. Much of this waste could be prevented with the introduction of some rationalization in housing.

(ii) *Inequality.* Inequality has come to be regarded as a basic and inescapable feature of society; moral, social, cultural and other arguments (including occasionally scientific) are advanced in its support. These arguments echo those in ancient Greece to justify the natural and divine law ordaining slavery. Inequality not only leads to exploitation of one person by another and one country by another, but leads to distortions in the production system itself and in social organization. Resources have to be spent to maintain this inequality, and the greater it becomes, the greater are the resources required to maintain it.

(iii) *Concentration of power.* The greater the inequality, the greater is the concentration of power in the hands of a few people who decide what other people should have or do. Consequently, any wastage of resources or other social distortions by those who have the power goes unchecked.

(iv) *Social costs.* The greater the wastage, the inequality and the

concentration of power, the greater are the social costs of maintaining the existing social order. The advanced countries which have developed industrial societies, based on an over-emphasis on individualism and profit, are now beginning to realize the social costs they have to pay for maintaining their societies. They have been able, however, to reduce their burden by exploiting the developing countries.

(v) *Impact on scientists.* Scientists have come to be treated like any other group of workers, whose labour can be bought when needed. With the spectre of unemployment looming large, and with increasing competition among them for resources and jobs, scientists have ceased to ask questions about the social purposes of their research. They have become an easy prey to, and a subservient tool in, the hands of those who provide resources to them.

We now require a fresh perspective in the light of existing knowledge and experience of the past and a more humane vision of the future. This perspective should be based on a careful analysis of existing social and cultural values as well as new values developed in harmony with our knowledge of the impact of science and technology on contemporary society; new goals have to be set accordingly. Unless a major effort is made in this direction, the crisis which we are now facing will become more and more serious, even though scientific knowledge may continue to grow and new technologies may continue to proliferate.

Science and technology and developing countries

The countries at present called developing, at least some of them, once had a highly developed science, and their technology was not inconsiderable. No systematic study has yet been carried out as to why these countries declined to their present level. Was it a failure of their scientific and technological system? Or was it due to colonization?

Colonization did indeed cause the disruption of their economy and social structure. Exploitation of their resources and markets by the imperial power forced them into a process of de-development. The process was expected to be reversed with the winning of political freedom, but this has not occurred. The current situation can be summarized as follows:

— The control over the natural resources of developing countries has further increased. The price of raw material exported has continued to fall in relation to finished products imported from advanced countries, placing the developing countries in an increasingly disadvantageous situation.

— Agriculture has been developed to provide raw material to the advanced countries, leading to growing imports of foodgrains. To increase production of both commercial and food crops, technology, fertilizers, pesticides and machinery must now be imported to meet the requirements of new varieties, making developing countries more dependent.
— Education has been patterned on the model of the advanced countries and, particularly at the university level, in the language of the Western countries. The educated classes are alienated from their own people and look to the West for guidance; on the other hand, they act as a pool from which the advanced countries draw their skilled man–power.

With each new advance in science and technology, not only has the gap between developing and industrialized countries increased, but the developing countries are being put to greater and greater hardship. Over the years since attaining independence, many of the developing countries have made major efforts to build up their scientific and technological infrastructure and have imported technologies to create an industrial base, but found these efforts being thwarted in various ways.

They have now come to realize that scientific and technical assistance programmes are politicized. Any support or aid which an advanced country provides to a developing country is part of the foreign policy and global strategy of the former. As a component of that policy, the advanced country gives advice to the developing country concerned with regard to the organization of its scientific and technical infrastructure, the nature of training to be imparted, the technologies to be imported, and the pattern of development to be followed. To implement the policies and programmes suggested, it offers equipment, and training to students, and lays down the terms and conditions under which these are to be provided.

This process ties the developing country down and makes it difficult for it to chalk out an independent path for itself. Those which have tried to take an independent approach have found that not only is the aid cut off, but pressures from various sources are exerted to make the country fall in line. In this context, the role of various scientific and technical experts, provided through various development agencies, including those of the UN system, should be critically analysed. In a number of cases, the developing countries have learnt to their cost that not only were these scientists and technologists not experts, but their primary concern was to promote the interests of their country, institution or company rather than those of the host country.

It has been the experience of most developing countries that when they send their research workers and students for training in advanced countries, they are inducted into areas of research primarily relevant to advanced countries. On return to their own countries, they are only capable of replicating the research, leading to investment which is irrelevant to the needs of the

developing country and which cannot be sustained. Consequently, such scientists either get frustrated and leave the country, or they try to forge close links between the scientific infrastructure of the developing country and the scientific centres in advanced countries. The result is the isolation of the developing country's scientific institutions from the social environment and from the needs of the country, reducing these institutions to serving as outposts of advanced country's science without any major local interaction.

Whatever technological transfers have taken place between the advanced and developing countries also require a critical examination. In many cases they appear to have gone through three phases. In the first phase, the advanced countries passed on to the developing countries outdated and obsolete technologies and equipment, which were going to be scrapped to make room for new technology or equipment.

In the second phase, they offered technologies to the developing countries to enable the latter to produce materials which they needed. A number of developing countries were persuaded to shift from food crops to cash crops to meet the demands of advanced countries. With the foreign exchange so earned, they imported more equipment, machinery, fertilizers, and pesticides, again to produce more of cash crops even if they had to import food. They thus became the satellites of advanced countries.

In the third phase, the advanced countries are exporting technologies to the developing countries with one or more of three characteristics – environmentally polluting (the product or process may even have been banned in the advanced country); labour–intensive (the advanced country can no longer compete in world markets with its high-cost labour); or extractive (the advanced country needs raw materials for its own industry). These technologies are also likely to be energy–intensive, thereby increasing the energy import bill of the developing country.

Besides technology, scientific knowledge itself is being used by the advanced countries as an instrument of political and economic control. For instance, using the latest scientific techniques available, they are able to map the natural resources of a developing country and use this knowledge to drive a harder bargain for themselves in extraction and exploitation of these resources. The recent spurt in oceanographic research, like space research, is an outstanding illustration. In areas such as meteorology or atmospheric or oceanographic pollution, the advanced countries are able to exploit scientific knowledge gathered and analysed through techniques which they have developed and monopolized, using scientists of the developing countries as technicians to collect basic data for them.

Other factors in developing countries themselves constitute obstacles to the use of science and technology to meet the needs of the mass of their people. Among these factors are: a lack of appreciation of the role of

science and technology as a major instrument of social change; narrow training of scientists as specialists, which inhibits them from acquiring an overall social perspective; and the creation of a modern industrial sector, with its links to R&D activity in advanced countries.

For science and technology to be effectively utilized by the developing countries, two conditions are critical. First, there must be a cadre of scientists with an inter–disciplinary approach to solving social problems and a strong commitment to serving the needs of the people, and capable of acting as a team. Second, there must be an adequate information system so that data are effectively utilized in making choices and working out suitable alternatives. Closely related is the need for a feedback information system for the scientists, planners and decision–makers to enable them to know how decisions have been implemented and with what consequences. The developing countries are severely handicapped with regard to both and depend on advanced countries, making themselves vulnerable to manipulation and exploitation by advanced countries.

The creation and expansion of a modern industrial sector affects a developing country in two ways. First, it sharply reduces financial resources and technological inputs for indigenous industry because these are increasingly absorbed by the modern sector. As a result, the traditional sector continues to depend on empirical knowledge and low–productivity technology, and finds it difficult to upgrade this technology and thereby meet the needs of the mass of the people adequately. Second, it creates and sustains an élite class which defines its material needs in relation to those of the advanced countries.

In the light of this situation, any programme for the utilization of science and technology for development in the Third World has to take into account the exploitation and unequal relationship between the advanced and the developing countries and the pressures exerted on the latter in various forms and in different ways. Unless measures are taken to remove the existing disparities and relieve these pressures, no effort through technology transfer is going to be effective. The question therefore is: Can the advanced countries be brought round, through persuation, to understand the real nature of the existing crisis and to join the Third World in the pursuit of common goals and objectives? Or will the advanced countries have to be forced into a less exploitative relationship with developing countries? The attempt of the OPEC to wrest some gains has been largely nullified through inflation, growing technological dependency, increased political tension, and import of arms. All efforts to evolve common goals to meet the existing crisis have come to naught. The crisis intensifies and our dilemma continues.

Giving a social orientation to science and technology

> *Never has humanity known so much power and so much confusion, so much worry and so much play, so much knowledge and so much uncertainty. In equal measure, does now anguish, now futility command the hours of the day.*
>
> – Paul Valery

The situation which Valery has so eloquently described is a result of the divorce between the forces generated by man and the human purposes for which they ought to have been utilized but are not. The emergence of new technological capabilities as a result of major investment of resources in men, money and materials, instead of being used to build an equitable and just social order, are being used for the purpose of making profit and acquiring power. The creation and perpetuation of social disparities, and the inability to distribute the benefits fairly within and between nations are propelling us inexorably towards the precipice of social disaster.

To correct the situation by preventing the irrational use of scarce resources by technology, we must return to the original purposes of science. Scientists created a culture and a value system which they then tried to spread in the society as a whole. They represented a tradition of intellectual integrity, objectivity, self–doubt, pursuit of truth, and a spirit of brotherhood. Subsequently, however, they got lost in their own narrow specialities and became primarily occupied with their professional advancement. In the pursuit of funds and name and fame, they lost sight of their original social purpose. Their spectacular successes clouded their vision. They isolated themselves from the historical and social sciences and other socially critical disciplines. They refused to relate the development of science and the emergence of various technologies to larger social issues. An erroneous belief was fostered that science and technology are value–neutral and culture–free and that they have their own independent laws of development.

We must review the interrelationships of science, technology, and society and bring science and technology back into the mainstream of total intellectual effort and social change.

To look at the problem of development in a mechanical way, ignoring the historical, social and cultural factors, leads us to treat the symptoms rather than the causes of the social disease. For instance, if a person is suffering from rickets, he is said to be short of Vitamin D, and so Vitamin D is given to him. No questions are asked about the kind of environment which produces rickets or creates Vitamin D deficiency. It is therefore not surprising that the real solution eludes us. It should by now be clear that unless the causes of underdevelopment are directly attacked, development will not take place.

All the aid given and technologies transferred only compound underdevelopment. This has, in fact, been happening in the developing countries over the past three decades. No development projects can succeed without a reconstruction of the existing social order along more just and equitable lines. They must also keep in mind:

— That if the beneficiaries of these projects are not clearly identified and their needs and interests made the criterion for decision-making, the benefits will flow, not to them but to others. An industry, established to meet the needs of the people but pursuing the goal of maximizing profit, can hardly be expected to produce goods to fulfil the primary needs of people. Food produced and/or processed for export in order to earn foreign exchange is hardly likely to find its way to the indigenous starving population.
— That no society is entitled to lay down the goals and the means to achieve those goals for other societies, if only because their cultures and traditions, their historical experience and their needs may be different. It is taken as axiomatic that what is good for the West is good for the rest of the world, and, further, that the path of development traversed by the West must be traversed by all societies. In most cases, individuals, industries and countries assume this and judge things and measure progress from this narrow angle.

In considering the role of science and technology in social change, what is required is a proper understanding of the historical and social context of science, its contemporary role in creating and extending disparities, and the need for moral standards to evaluate the social impact of science and technology. We need to make a major effort aimed at changing the motivation of people and arousing their consciousness regarding the goals of social living and the appropriate and humane means of achieving them. This will be possible only when a movement of social and cultural change can be initiated to make technological change an instrument for fulfilling the aspirations of the mass of people.

In initiating this movement, scientists should play a major role. For they, more than others, understand the significance and implications of contemporary developments in science and technology, the possible alternatives, and their social consequences. This is the role they played in the past when scientists were masters, not slaves of technology run berserk. And this is the role they must play now.

To obviate the danger of a small group of people, however knowledgeable and well intentioned, deciding the fate of humanity, social change must be based on the active participation of people in both arriving at and implementing decisions. In other words, objective knowledge and human aspirations should be blended in a programme of action with voluntary participation of the people. Science and technology will then be transformed

from a mindless instrument of exploitation of both man and nature into a humane means of creating a just and equitable society.

The problem of applying science and technology to development, if the goal is building a just and equitable society, involves a major transformation of the existing scientific effort, substantial modifications in existing technology, and fundamental changes in the existing relationship between the developed and the developing countries. Without this, the dichotomy between the possibilities and the achievements of science and technology will continue, and the crisis with which we are faced will deepen.

In the field of science, the main need is to end the social isolation of science and work out a major programme to disseminate scientific knowledge, popularize scientific values, and promote public debates on the implications of current technological developments for the benfit of the human society and the physical environment. Also necessary is a major effort to substitute social values for anti–social values which justify and encourage individual gain at the cost of society. Scientists have to act as critics as well as custodians of social and moral purposes. For this purpose, the UN should draft an international code to safeguard the freedom of expression of scientists. The criteria for selection of research programmes and techniques to incorporate social, cultural and moral purposes and non–quantitative factors in decision–making procedures must be developed.

In the field of technology, methods to assess technology in terms of its human and environmental impact and of future social needs have to be utilized in preparing legislation to direct technological change along least wasteful and most conserving lines. The UN should make a list of industries where waste can be avoided and recycling practised. It should identify key areas where codes of technological performance may be developed. It should also evolve international standards and norms. Once this is done, the necessary social pressures must be built to implement them.

The problems of technology in relation to consumption of energy, pollution, use of non–renewable resources and adverse impact on social systems have been extensively studied, and some efforts are being mounted to overcome them. Major hurdles, however, are raised on the national and international levels by groups with a vested interest in the existing technologies and the social systems which support them. A number of studies suggesting models of negotiations and methods of conflict resolution have been published recently. These appear to be mere academic exercises, useful only if no real action is proposed to be taken. They seek a solution within the existing framework of inequality and exploitation.

The only way to overcome vested interests and stop the misuse of science and technology for destruction and exploitation is through social action. In recent history, we have three examples where a combination of scientific

conclusions and insights coupled with social action brought about a new awakening and achieved some concrete results. In the US, the movements against environmental pollution, racial discrimination, and the war in Vietnam did have a major impact in changing national policies. The lessons of these movements could be learned and applied on the international level. Without the mobilization of public opinion, however, nothing can be achieved. The people who would be most effective and who have the most to gain are in a majority, those who have been denied the benefits of science and technology because of their misuse by vested economic and political interests.

We also need a new model of international cooperation to replace the present structure based on inequality and exploitation by the advanced countries of the developing countries. The reversal of existing relationships and the development of a genuinely cooperative model will require the de–politicization of international aid programmes; elimination of secrecy in science and promotion of a free flow of scientific and technical information; use of technical know–how to meet basic human needs in the developing countries; the adjustment of prices of raw materials and finished products in order to end the exploitation of developing countries; putting of a premium on consumption of non–renewable resources so that the resources thus generated could be used for the social benefit of the world's poor.

The most important need, however, is to reduce investments in research and development of technologies for human destruction and repression – physical, chemical, and biological. If this is done even to a limited degree, vast amounts of resources could be released for developing new technologies to meet neglected human needs in the Third World.

No outside support can help developing countries unless they make a major effort to help themselves. They have so far made soft and easy choices and avoided taking hard decisions, such as delinking their modernized industrial sector from industries in advanced countries. A major thrust must be mounted to strengthen indigenous scientific and technological capabilities to meet the needs of the people. If they want to avoid traversing the road taken by the advanced countries and paying a still heavier social cost than has been paid already, they must not shy away from hard decisions.

If UNCSTD and other forthcoming world conferences were to tackle issues such as these, concentrating on a redefinition of the term development to mean removal of inequality between and within nations, and on the use of science and technology to remove existing disparities, at least a beginning will have been made in working toward a more just and equitable social order. This would require the UN system to undertake a programme of taking science and technology out of the hands of narrow disciplines and acquisitive professions confined to cloistered laboratories and secretive factories.

History suggests that establishments, no matter how sensitive, well informed and 'progressive' they may be, are unlikely to act as instruments of pervasive social change. They are far more likely to serve as instruments of continuity in maintaining the existing systems and relationships. If so, the people will have to look elsewhere to bring about the changes they desire.

The endeavour is to search for better and better, let us see where human vision will now take us.
—Urdu poet Hali (1839–1914)

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SCIENCE AND TECHNOLOGY IN A NEW DEVELOPMENT STRATEGY

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This paper examines the conventional top–down framework of development, with its dependence on transfer of external capital and technology, and then attempts to formulate an alternative perspective primarily in terms of human development, participation and self–reliance. It identifies some issues relevant to technology development and choices within the new development perspective both in 'developed' and in 'developing' countries. It argues that techno–economic notions of development and marginal reforms contribute neither to a meaningful social change nor to development in wider human terms; a new man–nature–technology mix is required. Development in human terms requires new processes and a non–alienating technology, based primarily on [illegible] existence of more than one stock of knowledge and technology yet to be created. It raises several fundamental questions to which developmentalists and technologists alike must address themselves, and identifies some possible interventions based on actual experience for utilizing the full potential for scientific enquiry, and the systematic application of the results of such enquiry, to the task of transforming society in economic as well as human terms and enhancing the dignity and creativity of people everywhere. The paper thus attempts to respond to the basic question, with the new understanding of reality: Cannot 'another development' in technology help to reverse the zero–sum game, which the development process has become, and transform it into a positive–sum game?

I. Science, technology, and the human prospect

At no previous juncture in history have the world's peoples been more aware of the potential resources, scientific knowledge, technological capabilities and unprecedented opportunities available for the satisfaction of their needs, not only in narrower economic terms, but in wider social and human terms. And yet, the strategies that are being pursued by developed and developing nations alike seem to be leading to a dead end from the point of view of both national perspectives and global order.

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The development process as it has been unfolding in the past quarter century has multiplied the problems of both the developed and the developing countries, as well as those of individuals within each. Affluence and technological advancement have neither raised consciousness nor resulted in the improvement of the quality of life for people in developed countries. On the contrary, it has alienated them from their societies, polluted the environment, wasted resources, and generated fear and uncertainty regarding their basic values. The inability to manage their economic systems and the frustrations of youth are the clearest manifestations that even in rich countries some fundamental changes are required. In developing countries, not only have the larger masses who are poor become poorer, but they are increasingly unfulfilled and restive, without access to the elementary necessities of life – such as nutrition, food, clothing, basic medical facilities, and even safe drinking water. In practically all countries in both groups, irrespective of whether they label themselves capitalist or socialist, where the creativity and potential of people is unlimited, life still lacks a fullness, people are still manipulated and/or bureaucratically managed, resources still continue to be misused, and major social and political contradictions still remain unresolved.

Any attempt to do something about this situation through the use of scientific knowledge and its technological application requires, as a starting point, learning from the lessons of experience and the new understanding of reality, formulating a vision for the future on the basis of the awareness of possibilities for all countries and peoples, and setting in motion a new process of development which can benefit all humanity. The vision of possibilities, though not identical for all countries in the immediate future, should provide for development of poor countries in harmony with the basic requirements of rich countries. The fundamental and long–term interests of the larger number of the world's peoples can be reconciled, ensuring that the immediate requirements of poor countries are also met.

The 1979 UN conference on Science and Technology for Development (UNCSTD), the General Assembly's Special Session on the Third Development Decade in 1980, and other forthcoming international events – such as UNIDO III, and UNCTAD V – can help to rethink past experience and generate a searching discussion on basic issues at the national, regional and global levels. The issues discussed should help to clarify (i) what the development process is about, and (ii) what the relationship is between science and technology and the development process, so that a consensus may be reached on how science and technology could respond to the problems indicated above, influence future development – particularly in the next quarter century – and benefit human beings everywhere.

II. Rethinking the old framework of development

The framework that has influenced the development process in the past quarter century assumed that there were 'developed' countries and 'developing' countries, and that 'development' was exclusively a problem of 'developing' countries. It was believed that if the experience of the former, along with some resources and knowledge, were transferred to the latter, the gap would be narrowed. The objectives and processes were viewed primarily in economic terms, and great reliance was placed on economic factors. It assumed that rapid economic growth could take place, if there was central planning and control of the economy as a 'top–down' process, with emphasis on industrialization, modernization and urbanization. Capital, the factor in short supply, was conceived as the main input into the process. Internal capital accumulation would be assisted by inflows of foreign capital and technology. The cumulative benefits of this kind of growth in the modern sector were expected eventually either to 'trickle down' automatically or, at best, be handed down through administrative action to the numbers who in most countries are in the rural areas. Material accumulation was expected to solve other human problems.

The 'widening gap' between rich countries and poor countries – and the results of the 'green revolution' in making the rich richer and the poor poorer within poor countries – has led to the sharp questioning of the validity of this narrow 'techno–economic' view and approach to development, even in its own terms.

Apart from the model's validity for poor countries and its narrow orientation, the 'realities' of the quantity and quality of foreign aid and transfer of technology to supplement indigenous capital (the factor in short supply) and weak internal mobilization efforts have made the assumptions regarding possibilities of such rapid growth of little operational value. There is sufficient evidence even from World Bank and other studies to confirm that, by any standards, neither the quantum of aid, nor its quality, nor the kind of technology transferred from developed to developing countries was sufficient or appropriate. Apart from the apathy towards aid in most developed countries today, a growing body of opinion supports the view that the earlier kind of aid giving and technology transfer is a thing of the past, and may have actually helped to create 'soft' societies and increase the poor countries' dependence. Further, the multinational corporations, which control much of the stock of 'modern' technology and which have been the main instruments for its transfer, have extracted high prices for their know–how and equipments. The 'borrowed', highly capital–intensive, import–substituting technology, implanted in developing countries, have had little relation either to real factor endowment, particularly labour or to

the existing technological stock in poor countries. The entire process was wasteful and the contradictions were many.

Throughout the 1960s and early 1970s, some token attempts were made to modify the narrower techno–economic notions of development and effect some reforms. The reformists argued that a modified framework of economic development could still be made to work 'efficiently' if (i) distributive or social justice was built into the objectives; (ii) there was an element of popular participation in a still essentially 'top–down' planning process; and (iii) the UN's New International Economic Order ensured a continuous process of transfer of an appropriate proportion of the income and technology from rich to poor countries.

The reformist position continues to be based essentially on conventional development thinking. Even with redistributive justice built into it, reformists still consider the development process as mainly an economic exercise, subject to allocation of scarce resources. Further, it assumes a conflict–free social framework for change.[1] Despite evidence to the contrary, a 'harmonious' international system, permitting an orderly and continuous process of income and technology transfers from rich countries to poor, is also assumed. Underlying all this is the further assumption that the problem of development is still mainly in the developing countries and that a consistent set of 'policy packages' based on technocratic considerations, ranging from structural changes to investment decisions to employment opportunities, can be carried out from 'the top' with goodwill and assistance of developed countries and the international community.

Several conferences and studies, done recently within the United Nations system and in academic circles, have analysed the change in the nature of the problems confronting the world today and the magnitude of the 'crisis' in development, in both developed and developing countries, and its national and international dimensions. There is now a great deal of consensus on the causes of failure of the development strategy of the past quarter century, and

[1]It is necessary that the myth of the existence of a conflict–free social framework is exploded if realistic interventions are to be made to bring about changes at the village, national and international levels. For instance, typically, Asian villages do not represent homogeneous economic and social entities. The relationships have a 'prism' effect, which distorts any purely technocratically oriented thrust, because unequal social and political relationships tend to reproduce themselves. Without first understanding the basic contradictions in society – the dominance–dependence relationships, the power of the dominant to bring about a crisis of immediate survival for the poor, the divisions among the poor itself, the inhibitions of the poor from taking economic, social, political initiatives for improving their lives etc. – no feasible strategy can be formulated. For further insight into the sharpness of the contradictions that exist and its implications for social change, see G.V.S. de Silva, Niranjan Mehta, Anisur Rahman and Ponna Wignaraja. 'Bhoomi Sena: a struggle for people's power' (Bombay, August 1978).

the depth and nature of the social and political problems before both developed and developing countries which, if left unresolved, would lead to 'great disorder under heaven' by A.D. 2000.

The causal factors for the global crisis are now recognized to exist not merely in the developing countries, but also in the developed countries and in the actual functioning of the global system.

On a more positive note, however, there is increasing acceptance in the current development dialogue of the following:

(a) Development is fundamentally about human beings, and they must participate actively in decisions affecting them.

(b) Development is now the mutual concern of rich and poor countries alike, and it has to be viewed in its totality.

(c) The world's resource potential and technological capabilities are sufficient to meet the reasonable felt-needs of men and women everywhere, if properly mobilized through the release of humanity's creative energies.

(d) Development is not an imitative exercise, borrowing a ready-made package, but an endogenous process of social change which each country must operationalize in keeping with its own values, political systems and resource endowment.

(e) A flexible global system can be evolved to supplement national efforts and be mutually re-inforcing with those efforts.

What this measure of agreement implies is that, instead of prolonging the debate on whether the old framework can work and *a priori* theorizing in terms of values and processes of the past, a new vision of development must be attempted on the basis of an understanding of the actual historical experiences of rich and poor countries, their current realities and their future potential. With this vision and the understanding of reality, it would also be possible for change agents at any level to identify meaningful interventions into the existing processes and to initiate social change. Different transitional pathways will be open to different countries.

III. Towards a new strategy of development[2]

The new conceptual framework, beginning to emerge on the basis of the above consensus, not only responds to the new driving forces for social change in evidence all over the world, but also permits a linking of the critical

[2]No label has been given to this strategy, though the term 'another development' in the sense used by the Dag Hammarskjöld Foundation would appear appropriate. The use of any other

interrelated phenomena affecting development everywhere. It also demonstrates that the response to these driving forces for social change cannot come from a reform of the old framework of economic development, functioning more 'efficiently' with distributive or social justice built into the process. It requires, instead, a redefinition of the philosophy and objectives of development in human terms and a total mobilization effort suitable to the ecological and technological reality, as well as the potential in a new man–nature–technology mix. Redistribution is simply not the issue. The new framework must reflect an integration of available knowledge and a sense of purpose going far beyond the narrow view of development in the old framework.

Country specific sub–models will evolve in the process of making the new framework operational, permitting pluralism within this world–view. An overview and perspective consisting of a new set of broad objectives and a new process consistent with these objectives is, however, a necessary precondition if the sub–models themselves are to be operationally valid. A supportive international dimension on new terms with new institutions will also have to evolve in the proper sequence. It will not be a mere quantitative extension of existing international economic relations, but one which emerges as the new process of development is set in motion.

The elements to be included in such a conceptual framework should be tested against the following criteria:

(a) The objectives of development should be cast in fundamental humanistic values, rather than in narrow techno–economic terms, i.e. new man–man relations.

(b) The development of the productive forces within new relations of production and an accumulation process within a realistic assessment of the natural resource endowment and the available technological potential must be set in motion to meet the felt needs of the people, i.e. new man–nature relations.

(c) The ability to mobilize, conscientize and organize communities – national and international – to tackle their respective problems is a critical and indispensible element in the process, i.e. a new social consciousness and organizational forms.

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label at this level of conceptualization could only add to the semantic confusion among those who are otherwise in full agreement with the essence of the concept and the cultural and technological pluralism it implies. See 'From the village to the global order: Elements in a Conceptual Framework for Another Development', *Development Dialogue 1977*, 1.

New objectives

The main objectives of an alternative approach to development can be briefly summarized. People are the world's greatest asset; bringing out their creativity and potential is the means as well as the end of development. A strategy of development which does not look upon people as an asset in development can only lead to a dead end.

People must be de–alienated and must feel at home with whatever process is initiated. It must progressively satisfy their needs, and they must participate in making decisions that affect them.

Self–reliance and the development of the collective personality of men and women so that they can contribute to nation–building is naturally a basic element of this new strategy. The new strategy is characterized by the innovative genius of the people in shaping their development and is an expression of their faith in their own abilities. This implies the elimination of 'dependency' relationships, irrespective of whether they are of a national or international character, development through a country's own effort, and recognition of the value of mututal assistance. Self–reliance is not to be confused with a narrow concept of self–sufficienency or autarky, and elements of necessary interdependence can be expected to flow from the process as it unfolds.

New process

To achieve these objectives, the conditions for social and economic progress are simply those that release the energies and creativity of the people and mobilize these for the all–round development of their lives.

Continuous social transformation of enormous magnitude has to be envisaged with meaningful transitional strategies yet to be worked out. A 'big bang' type of revolution is not always the answer. In many countries political space exists, along with the seeds of change, which can be replicated through new processes.

There is, of course, no easy way to bring about the structural changes required. The political space has to be identified, and interventions on the basis of seeds of change already in evidence would need to be organized. These interventions themselves have to be supported by an integrated process of total mobilization, which involves raising people's consciousness and inculcating democratic values, the transformation of labour power and creativity into the means of production, fullest utilization of local natural resources, and the systematic development of appropriate technology. For most countries, this is also the only viable method of accumulation

leading to faster economic growth. There is now sufficient historical evidence to validate this process of total mobilization. Such a mobilization process flows from the consensus relating to development now emerging and can be consonant with the objectives stated above. As mentioned earlier, it implies new man–man relations as well as new man–nature relations and a different man–nature–technology mix.

There are four critical elements in the total mobilization process:

(a) For this process to be effective, increased mass consciousness, a committed leadership which trusts the people, participatory democracy, decentralization of decision–making, building countervailing power and a continuous self–correcting mechanism, which the people themselves will devise, are necessary. This is the essence of a democratic ideal.

(b) Transformation of labour into the means of production cannot be achieved by the mere offering of employment contracts. People have a right to work creatively and have to be stimulated to work through collective participation in production and in a range of other activities within their own communities. The capital fetishism of the past must give way to the fullest utilization of labour power and creativity.

(c) A new definition of resources is called for. Every blade of grass should be looked at as a possible food item or raw material for industry or an import substitute. Sunlight, wind and waste are renewable sources of energy. Local resources will not be allocated and distributed through the dictates of the 'market' mechanism', but in response to satisfaction of the felt needs of the people which become 'effective demand' as a result of new institutional changes, i.e. equality of opportunities and access to assets. This also implies a new product mix and the satisfaction of local needs as far as possible by optimal use of local resources, with gaps being filled by surpluses exchanged, first, with neighbouring areas and, thereafter, with more distant areas, and so on.

(d) The technology involved will not be an outright transplantation from other environments, but one which integrates human development with available local resources. In other words, the strategy of technological choice is related to the basic social philosophy and the resource position. While the process will start from the existing level of technology and improve upon it, sophisticated technology and newly created technology will also be used and will reinforce the linkage between the two to achieve the overall objectives of the new development strategy. The flow would not be in one direction; rich countries would also borrow appropriate technology from poor countries on equitable terms. The technology used should be non–alienating by enhancing the dignity of the individual; it should help to bring about natural environmental and psychological states.

The pursuance of such a strategy has far–reaching implications for the basic values and the life–styles of the people in all societies, both developed and developing. It would be necessary for the countries to go through continuous transformation with a period of shared austerity, if required, for ultimate good until such time as the new process is under way. Efforts towards self–reliant development as the key orientation for the new strategy require articulation of the felt needs of development by the people themselves. They also require a corresponding reorientation in the international relations system towards collective self–reliance in order to provide further impetus to the steps already initiated in support of a new international order.

Development should be seen as a total process. The technocratic approach, which has influenced thinking and action for the past quarter century, has fragmented the process into narrow specializations. A re–examination of the total approach, which is essentially socio–political, is urgent in order that the process may respond to the needs of the times. Transforming growth–oriented societies into humanistic and self–reliant elements in a global community of nations demands bold and imaginative steps, commitment and participation by all concerned. The overall framework outlined above should, however, be viewed, not as a rigid blue–print, but as a perspective to enable people to determine what they require to meet their needs.

IV. Issues for the development of science and technology

The full potential for scientific enquiry and the systematic application of the results of such enquiry to the task of transforming society and enhancing the dignity and creativity of man are yet to be realized.

In the old framework, the concept of modernization and the imitative process of the developed–country experience implied the existence of one stock of scientific knowledge and a technological pool to be transferred from the developed countries, which had the stock, to developing countries, which were without them. The assumption also was that science and technology were technical issues and related mainly to the production process. Their wider political, social and environmental implications, and the question of who controls technology, were hardly raised. The existence of other stocks of knowledge and techniques were ignored.

Today, with the known social ill effects of technological developments on the lives of people in rich and poor countries, and with the failure of the development experience of the past to reach the masses in poor countries, the whole role of science and technology in development and their wider

implications for the future of humanity and global order are assuming primary importance. Issues such as the inadequacy of the old transfer mechanism, the distortions introduced by the main actors in the process, and the possible improvements to the transfer process itself are of secondary importance.

The fundamental questions to which developmentalists and technologists alike must address themselves include these: What kinds of scientific knowledge and technological application are required to bring about the new kind of development? How can technology be better related to resource endowment? How can technological relations themselves be non–exploitative so as to improve social relations? Are there other stocks of scientific knowledge and technology which already exist, even from unconventional sources, which can be immediately harnessed? Does a new stock of scientific knowledge have to be created to deal with emerging problems of the large masses of people along with an appropriate technology? Who should develop this appropriate technology and how? What are the wider implications of the brain drain for developing countries? Should not the transfer mechanism itself be looked at, first, in terms of a two–way flow from rich to poor countries and vice versa, where selective transfers from rich countries may help to overcome some economic problems of poor countries, and, secondly, in the reverse transfer of some technology from poorer countries on equitable terms to help alleviate social problems in rich countries, with a third flow between developing countries with similar problems and interests? All these issues are interrelated and must be looked at simultaneously.

The results of *ad hoc* development of technology can be illustrated. There is, for instance, a growing concern about the long–run implications for humanity of the rate and pattern of current resource use, especially related to the arms race and non–renewable energy sources, by the developed countries. The concern extends to the present pattern of consumption in terms of already evident environmental degradation, on the one hand, and the long–term supply–demand balance of essential materials, on the other. Recent experience in developing countries, with the introduction of high–yielding seeds and chemicals in an effort to increase cereal production but within a traditional framework of rural institutions and land ownership, also shows the distortions in terms of income differentials and social divisiveness of technological change when pushed through without reference to socio–political consequences.

In short, the problems of technology development can no longer be separated from the larger political and social crisis confronting the world. As the new development process unfolds, sporadic and *ad hoc* changes in the present system of technology development and transfer will not be adequate. A systematic attempt has to be made to identify all available scientific

knowledge, and for each country to develop the kind of technology mix that will be most responsive to the needs of its people. The needs of each country will be different, and within a country a technological pluralism will give optimal results. A very wide range of technologies will have to be developed to deal with immediate concerns as well as long-range problems.

For purposes of the 1979 UN Science and Technology Conference, several strands of scientific and technological development may be identified. Some would respond to the immediate felt needs of the people in the two broad groups of countries – developed and developing – and build upon or adapt the existing technological stock in the particular country, taking into account the needs of its people and its resource endowment. Another strand would focus on newer problem areas. A greater part of this development will of necessity have to be undertaken by the countries themselves, or groups within countries, though a part of it could be better undertaken by joint or collaborative efforts at the regional or international level.

Developing countries

For poor countries pursuing a self-reliant humanistic development strategy, the main internal focus would be on the development of technology to suit the felt needs of the masses and one that would be consonant with their cultural values. This implies, for instance, technology which would not be highly specialized and which would permit the large numbers to be involved in developing it as well as utilizing it. The selective borrowing of technology from rich countries, or those in a similar stage of development, on fair terms would not be precluded. But there should be a precise analysis of what is being transferred, what are the processes and who benefits. Specific criteria would need to be established on how to select and how to borrow. The lack of criteria has resulted in the past in importation of complex chemical fertilizer plants, using foreign technology and expertise and involving a major foreign exchange commitment when recycling of waste products may have been cheaper, more appropriate, and non-alienating. Short-distance transportation by motor vehicles, rather than the bicycle, has its own attendant adverse consequences without helping to solve the particular kind of transport problem in poor countries.

Although the majority of the people in poor countries live in rural areas, the technology sought and transferred under the old framework has five significant biases which have had far-reaching implications for them:

(i) It is capital-intensive in a situation where capital is the scarce factor.

(ii) It has influenced the location and organization of production, favouring urban industrial development to rural development.

(iii) It has further distorted income distribution and the already skewed consumption patterns which, in turn, are reflected in disparities in income within poor countries themselves.

(iv) It has reinforced the existing distortion in the education system, catering mainly to an urban élite and alienating the educated youth from applying themselves to the real problems of development.

(v) Internationally, it has intensified the country's balance-of-payments difficulties, partly through having to pay exorbitant prices for this imported technology, partly through the continued commitment to use imports to keep the imported technology functioning. Above all, this technology cannot be absorbed by large numbers of people and has little relation to their real needs or creative capacity.

As has been mentioned earlier, the process of development of suitable technology will include technologies of differing degrees of sophistication. It should start from the existing level of technology and systematically improve upon it, with highly sophisticated technology being used where it is in keeping with the new objectives of development. Four elements in the development of technology suitable for poor countries may be identified:

(a) In order to set this process in motion, it is clear that the appropriate educational and research infrastructure has to be built. In the last 25 years, there has been an expansion in the education and research systems of poor countries; but they need to be restructured to the requirements of the new development objectives and processes, e.g. learning by doing, dialogical and participatory action research etc. The new education system should not concentrate merely on making people literate. It should also help in raising mass consciousness, in improving the technological base of agriculture, rural industrialization and allied activities. An altogether new schooling system to release the creativity and innovativeness of the people and shake the age-old inertia may have to be launched. Students, administrators, technical experts should go out to the villages and work with the people to bring out a scientific approach to life. The Kerala Sastra Sahithya Parishad in India is an example of a movement to take science to the people and learn from the people.[3]

[3]The Parishad is a voluntary movement started at the initiative of a handful of popular science writers 15 years ago. Today, it has grown into a unique mass movement. Parishad workers, consisting of doctors, engineers and others discuss with people on the streets and in the villages topics which were considered beyond the understanding of the common man. In 1976, the Parishad conducted 10 000 classes on 'Nature, Science and Society' in the Kerala villages in schools, rural libraries and in the evenings in the market-place. In 1977, the subject chosen was 'The Resources of Kerala'. The idea was to explain scientifically and socially why Kerala remained poor and backward while it was one of the resource-rich states in India. This year classes have been planned on agriculture and health as entry points to human and social development.

(b) To operationalize this approach, a new type of action research project will have to be initiated. Researchers will need to integrate themselves with the daily lives of the people and enter into a method of dialogical and participatory research. Here, the close identity established stimulates uninhibited responses, from reminiscences and reflections from the people. In this process, the accumulated knowledge of the people is brought out as new concepts and options emerge.

The infrastructure for R&D of this type will have to be built, and some R&D activities will also have to be of an unconventional type. First, scientists and technologists from urban centres and even the nationals currently abroad must be mobilized and sent to the countryside. These people who have advanced scientific and technical knowledge should interact with local artisans and verteran peasants. In this way, a new understanding of reality can emerge and an inventory of traditional and locally available (and perhaps half-forgotten) techniques of production, health care and other social services can be made. This approach is quite different from the conventional extension services which attempt to 'transfer' modern technical know-how to the people.

Second, a resource survey using, if necessary, sophisticated methodologies should be made. Resources are not necessarily limited to those items that are already familiar or known. Resources may be hidden in the jungles and valleys, or they may be materials currently considered as waste. The advanced scientists together with the local artisans, peasant veterans and other 'barefoot experts' should enter into a dialogue and improve on traditional techniques and make maximum use of local resources. In this process, some weed or some waste may turn out to be a food item or a precious 'import' substitute, e.g. the Azola weed or the water hyacinth. The recent experiments being conducted under the auspices of IPCORI, the Atomic Energy Commission in Bangladesh, are a case in point.

Experiments in developing biogas and fertilizer from waste in several countries are also testimony to the potentialities of this kind of mobilizational approach to innovation. A process of this sort can also establish its own dynamism and momentum for becoming more sophisticated, inculcating a scientific temper among the masses within a reasonable time perspective and assist in creating an R&D infrastructure to develop it.

(c) A third element in the strategy for developing appropriate technology in poor countries would be to selectively use sophisticated technology. For instance, in most poor countries renewable sources of energy are lacking and have to be imported at high cost. Sophisticated technology could be used to develop such new sources of energy, e.g. solar energy. Unlimited availability of sunlight, unlike the fossil-based energy currently in use, can provide a continuing source of energy. In an earlier reference, solar energy through

the nitrogen fixation process also transforms the Azola weed into a new source of fertilizer for the rice fields in poor countries. Simple and less costly techniques for using solar energy could be evolved. Another example relates to natural resource surveys mentioned above. Prior to embarking on rural development programmes, the full economic potential of an area may be ascertained, using aerial photo techniques. The information gathered should be made available to decentralized decision–making groups. It is necessary, in using sophisticated technology, to be clear on the social implications so that the 'green revolution' experience (which benefited only the few) is not repeated.

Several poor countries have a limited supply of highly trained scientists who can help to create this technology. There is a much larger reservoir that can be mobilized for this task through a reversal of the brain drain. This requires a reorientation of national priorities to meet the needs of the new development.

(d) The fourth element would be selective use of 'borrowed' technology. In the old framework, it was the lack of selectivity, and the paying of high prices for it without securing any control over it or its reproduction and adaptation, that caused the problems of technological dependence and exploitation. In many cases, it is not merely selecting from existing technologies in rich countries; new technologies may have to be created in the latter before transfer could be considered. Social control over transferred technology and careful negotiation of the terms of borrowing are an essential element in reducing the earlier shortcomings.

Technical cooperation among developing countries, i.e. sharing of technological knowledge and skills among countries with similar problems and at a similar stage of development, is both a source of suitable technology and also a safeguard against transfer of inappropriate technology on unfair terms. There has been a great deal of discussion of TCDC in the recent UNDP sponsored conference in Argentina, so no elaboration is attempted here.

By way of an example of how social change and new technological development can be linked with a new development strategy for poor countries, one case may be cited. In Papua New Guinea, where self–reliance is one of the stated aims of the development strategy, a Health ministry technician, taking advantage of a government policy which permitted anyone working with government to take one–year leave on half pay to work in his village, returned to his village and began exploring the possibility of getting the people to help themselves. Focusing on gastro–intestinal diseases and malnutrition, which were widely prevalent and a cause of major concern to the people, he set in motion a process of discussion among them in the

traditional village forum to analyse the causes and find solutions. First it was found that, despite having wells, the water was polluted because the wells were not bunded or covered. Once the people got together and bunded the wells to resolve this problem, it was possible to get them to agree to collect rain water for the same purpose. This led to the harnessing of a tank which was located six miles away beyond a hill, using simple technology and people's participation. Wind energy was used to lift the water to the top of the hill which was then brought down by the gradient. This ensured a permanent water supply for drinking as well as for irrigation facilities for village agriculture. This then led to increased and diversified food crop cultivation and livestock breeding with consequent improvement of income, nutrition, elimination of gastro–intestinal diseases, environmental sanitation and, what was most important, reinforcement of the community spirit which was an integral part of the Papua New Guinea culture. Such examples of rural mobilization, using a change agent, raising mass consciousness, participatory people's organizations and the development of mass science and technology, where the perceptions of the people are enhanced through discussion, can be seen scattered in all countries of Asia, e.g. Kishore Bharati and the Kerala Science Movement in India. The most comprehensive example of such a process in recent times can be seen, of course, in the case of the Chinese Commune.[4]

Developed countries

For rich countries, too, there needs to be a basic reorientation of technological development. The private appropriation of technology should be subjected to social control. Problems of alienation, pollution, and resource waste should receive the highest priority. Further, they should cooperate internationally in developing new forms of non–alienating technology for the benefit of all mankind in collaboration with scientists all over the world, irrespective of nationality.

The above aspects may be further elaborated.

(a) Some examples of attempts to resolve major social problems by adapting new techniques are already in evidence. For instance, some automobile manufacturers in Sweden have moved from assembly line to 'group' technology and work habits to improve social relations in factories. In 1977, shop stewards in the Lucas Aero Space industry attempted to

[4]Ward Morehouse, 'The Commune as a Technological System: Notes on Hua–Tung Commune', *The China Quarterly*, September 1976.

change production in keeping with their needs. In Denmark, in Ulfborg, after the energy crisis a new type of windmill has been built, using electronic devices to get maximum benefit from the wind as a source of energy. It is estimated that 1000 mills like this can be built for the cost of a nuclear plant to provide an alternative to nuclear power for civilian use.

Environmental concerns, such as pollution and waste of resources, are beginning to be tackled, but they need to be systematically studied and the effective solutions more widely applied. In this process, some older technologies may need to be dropped. The entire industrial base in a rich country is built on the use of non–renewable fossil fuel. As the depletion of stocks of this fuel draws closer, energy from unconventional and renewable sources must be found, along with methods of conserving existing sources through adaptation of existing technology.

A reverse transfer of certain technologies from a poor country's stock to rich countries may also be needed. For instance, there is a body of scientifically tested knowledge and techniques available in poor countries which could be used to prevent and cure psycho–somatic and stress problems in urban industrialized societies. These techniques could be harnessed and built into the health care systems of rich countries. In areas of urban renewal, some poor countrys' experiences and low–cost solutions could be transferred to resolve rich countrys' problems. This stock of technological know–how has not been explored by rich countries to reinforce a system of mutual assistance. The unplanned brain drain, however, does reflect a reverse flow, but one which has adverse effects on scientific and technological development in poor countries. The reverse transfer has to be effected in a more egalitarian framework, and not to make the 'rich richer' or the dominant more dominant.

(b) In assisting poor countries to develop relevant technology, the old transfer mechanism must be brought under social control through negotiations to ensure equity. The current inter–élite negotiations themselves enhance the inequities in the transfer and have to be replaced. Patent and copyright systems and codes of conduct will need to be reformulated or created so as to ensure greater equity. In addition to improving the mechanism for selective transfer of technology from rich to poor countries, rich countries can assist poor countries in building their infrastructure for R&D and in facilitating the reverse flow of selected technology from poor countries to rich wherever it is mutually beneficial, but within the wider framework of social change essential in both groups of countries.

(c) Rich countries with their technology should cooperate internationally in developing new areas of resources for the benefit of all mankind. The development of the sea–bed and new energy sources are obvious examles. To the extent that these have to be developed in the interest of

future generations of people all over the world, this effort should be internationalized so as to ensure that it will be non–alienating and the benefits will be equitably shared.

These are strategies that can easily be adopted by rich countries. The question is : Will they adopt these strategies? Or, rather, what motivation can they have for doing so? If they continue to show no inclination to do so and continue to rely on co–opting the international organizations set up to assist poor countries to develop their technological capabilities, then the poor countries may have no option but to de–link and mobilize their own dormant potential.[5]

V. How to begin an effective transition

The broad perspective outlined in the previous sections of this paper and the questions raised, not only permit a deeper understanding of existing processes and the relationship between technology and human development, but also enable the intellectual community and change agents at any level to consciously intervene in the existing processes and bring about social change in the desired direction. The implication is that every individual who considers himself an agent of change has a role and can intervene. This is an essential element in the 'long revolution' as opposed to a once–for–all 'big bang'.

The progressive intellectual community as well as the United Nations system can play an important vanguard role in this process of social transformation by helping to sharpen the debate not only between those who want change and those who essentially want the *status quo* (often disguised as marginal reforms), but also between those in the former category who are debating different transitional strategies involving ideologies, the pace of change and structure.

What technology is being transferred? What are the processes? Who benefits? Is mere selectivity and regulation to mitigate the ill effects of the transfer from rich to poor countries sufficient? What traditional technology exists in poor countries? How can this be upgraded? How can new technology be created in both rich and poor countries to meet the objectives of

[5]In a consultative meeting convened in Kuwait in 1977 by Bradford Morse, UNDP Administrator, in preparation for the TCDC conference in Argentina this year, considerable evidence was brought out to indicate that UN agencies established to assist poor countries to develop appropriate technology had themselves been co–opted as instruments for the transfer of existing and alienating technology from rich countries to poor. See 'Kuwait Declaration', which was issued at the conclusion of the meeting.

development in wider human terms, which includes meeting the economic needs of larger numbers? Having asked these questions, it is necessary for change agents at all levels to go beyond this and *initiate* a 'new total mobilization approach' to innovation and social change with appropriate technology as one entry point. As has already been mentioned, there is a considerable body of experience in introducing innovative technology within the new conceptual framework of human development, and developing new forces of production within new relations of production and at a higher level of consciousness of all those involved. These experiences need to be identified, analysed in greater depth and the lessons systematized. Many committed individuals and groups working under varied social and political conditions have contributed to enlarging this body of experience. Generally, these persons are isolated and need to be knit together so that they can exchange experiences and interact over a period of time long enough to create collectively and reinforce each others' efforts. In some cases, these experiences have not remained isolated one from the other, but have been replicated even on a national scale. This is the new area for action research, through the methodology of praxis, dialogical and participatory research, etc.

In several countries, the political and economic space exists for further experimentation, for the planting of seeds of change and replication. What is needed is new forms of investigation, dialogic and participatory research between the experts and the people, training and sensitizing of change agents to facilitate planting of seeds, and replication of the process based on available evidence which provides guide-lines for further operationalizing the concepts outlined above on a massive scale. Thus the next stage in the process is clearly to systematically organize this body of knowledge and experience, use it to further mobilize change agents committed to moving out of the dead end in rich and poor countries and to reinforce the efforts of these elements in moving into the transitional pathways to social change in the desired direction.

In a real sense, the process of change towards 'another development' has begun; it cannot be stopped. The process can be strengthened if the fraud and/or confusion in the current debate on development itself is refined and sharpened and, while continuing experimentation, bold action based on available experience is initiated by those who want change. The positive experience demonstrates that there is no need for those who want change either to be tentative and continue to grope in the dark or be lulled into a sense of complacency by the rhetoric of change from those who are merely tinkering with the processes. Let the rethinking, even within the United Nations system, go well beyond talking of development in human terms, calling for change of heart of multinationals, getting the prices right, or more

'efficient' delivery by the existing types of delivery mechanisms and bureaucratic organizations. Let a new mobilization process based on a different man–nature– technology mix be initiated. This would constitute a meaningful forward step on the transitional path through another development in technology to Another Development itself.

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SCIENCE AND TECHNOLOGY: THE AFRICAN SEARCH FOR A THIRD WAY TO DEVELOPMENT

John W. FORJE*

Development strategies so far followed in the Third World are now being increasingly questioned because they have not led to meeting basic human needs and also because they promote Third World dependence on the developed nations. Science and technology of the Western kind only perpetuates an already deteriorating situation in Africa. Although no nation can develop in isolation, African countries must initiate, control and direct their own pattern of development. Peaceful co-existence and progress for all mankind can only be a reality if the North and the South embark on a harmonious and simultaneous process of reshaping the existing international order, including the technological order.

Development in Africa: obstacles and opportunities

Since 1945, two principal alternative paths to development – one capitalist and the other socialist – have been presented before Third World countries, and they have been called upon to choose one. This has facilitated the extension and intensification of the cold war in the Third World, each side using its particular approach to woo new friends among the developing nations.

The time has now come for the people of the Third World, including Africa, to ask why both the approaches have, by and large, failed to steer development in the right direction. Why are the Third World nations poor in the midst of plenty? Why has development of either variety failed to narrow, let alone close, the gap between the 'haves' (mostly in the North) and the 'have–nots' (mostly in the South)? Why do developing countries find themselves in a situation that only aggravates the misuse of human and natural resources for the benefit of the industrialized world?

To understand the phenomenon of underdevelopment in the Third World, one must look into the past. If colonialism arrested development, the

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legacy it left behind constitutes a major obstacle to Third World development, although the situation is not the same in all countries. On the Asian continent, the two giant nations, China and India, by virtue of their population and size, have options for developing relatively complex scientific and technological infrastructures. The countries in Southeast and West Asia (with some exceptions) are caught in a growing web of technological dependence on the West. This is especially true of the OPEC countries which have found no better use for their petro-dollars than investing them in massive imports of Western technology, largely of a military nature. The Latin American countries, because of their orientation to export to the industrialized market economies, especially the United States, and because of the latter's dominance in the area, find themselves caught in a web of technological dependence on the US. The result is 'the incapacity of Latin American countries to use scientific and technological research as dynamic elements for social development'. A critical factor is the role and influence of the big brother of Latin American elites, the USA, 'which directly and indirectly teams with groups who until now have had political and economic power in most countries in the region.'[1]

As far as Africa is concerned, the almost total lack of development of the modern sector in Africa (with the possible exception of Nigeria) gives that continent greater opportunity than to most countries of Asia and Latin America to devise its own distinctive developmental path. This is, however, not to say that the economies of African countries are not export–oriented or that they are entirely untied to the Western metropolitan centres in which the European Economic Community (EEC) now plays a dominant role. This is indeed an obstacle, but Africa's opportunity lies in its relative freedom from the so–called modern large–scale industries.

Decolonization and dependence in Africa

It must be recognized that the obstacles in the way of following a distinctively African model of development are formidable because of Africa's continuing position of dependence in the international system. Political independence has only created the illusion of total independence, but has, in fact, perpetuated the reality of dependence arising from the economic structures of developed and developing countries, i.e. the dominance of the

[1] *Amilcar Herrera*, 'Social Determinants of Science Policy in Latin America: Explicit Science Policy and Implicit Policy', in *The Journal of Development Studies* 9, 1, October 1972, p. 19. See also Charles Cooper (ed.), *Science, Technology and Development*, (London: Frank Cass & Co. Ltd., 1972).

centre over the periphery. The economic power and technological supremacy of the centre are, after all, typical of the underdevelopment syndrome of the entire Third World today. Consequently, African countries, like the rest, suffer from constraints imposed by the international economic and political system dominated by the centre. Thus, development to meet the basic human needs of a majority of the people becomes extremely difficult. The problem has been succinctly stated by William Zartman:

> .... Western habits of consumption and other values of the dominant politico–economic system remove the need for direct intervention and indirect colonial rule; the more the new elites develop, the more their expectations rise, the more they become programmed to look North, to think Western, and to alienate themselves from their national society which is locked into underdevelopment.[2]

It is therefore not surprising that political leaders and other elites in most African states have refused to be masters of their countries' development but have accepted a pattern of development dictated to them from the metropolitan centre. Metropolitan influences are being diversified along multilateral lines to include ties with non–colonial metropoles – such as the Scandinavian countries, Austria, Switzerland, Ireland, Poland and Romania. These multilateral relations have been evolving through institutions like the EEC, the European Free Trade Association (EFTA), the Council for Mutual Economic Assistance (CMEA), COMECON and NATO, to name but a few. What all this means is simply that:

> As decolonization moves forward, it moves into less certain grounds where the rights of the new nations are less clearly related to the simple equality of sovereignty and where its ability to replace former metropolitan sources is less sure. It must also build up its own capabilities, for a state cannot thrive on rights alone. As decolonization proceeds, *the new states may eliminate elements* that are actually useful to them in the short run in order to get rid of debilitating habits of dependence. For the process to operate most efficiently, decolonizing ... states must use the remaining elements of European presence to create the capabilities needed to replace that very presence.[3]

A thorough grasp of these larger historical processes is essential as the African states prepare for the forthcoming international conferences. But the more immediate issue remains: How to get out of the situation as it is today? It is a question, in the first place, of identifying their most crucial problems. Is it poverty in the midst of plenty? Is either the capitalist or the socialist approach to development the right path to solving their present underdevelopment? Are there other alternatives? If, so, how can these alternatives be best employed in the environmental, economic, cultural and political circumstances of individual African countries? In what way can the international community contribute, assuming that it is willing?

[2]William I. Zartman, 'Europe and Africa', *Foreign Affairs 54*, 2, January 1976.
[3]ibid.

African development strategies for the 1980s

African countries require two strategies in formultating science and technology policies for national development. A short–run adaptive strategy is necessary to cope with the present condition. But a long–term 'reconstructive' strategy is equally necessary for a distinctively African development. These two strategies must be developed simultaneously, not sequentially, as components of a larger whole. In formulating these strategies, African countries must keep in mind the harsh political and economic realities of the role of science and technology in the international system today. The international politics of science and technology, as practised today, is not directed towards fighting human suffering so as to improve the lot of the untouched majorities in Africa (and elsewhere in the Third World) but towards perpetuating the prevailing centre–periphery relationship.

Developing appropriate strategies depends upon perceptions and institutions which are yet to take shape. African states have yet to give serious attention to creating their own institutions instead of continuing to depend upon outside advice and recommendations that often have little relevance to their environment or their balanced development. African states seem prone to see their problems through the eyes of experts from metropolitan countries. The result is that the arrangements which African countries devise for dealing with their problems are largely those of the industrialized countries.

To formulate sound development policies, it is vitally necessary for the decision–makers to encourage themselves and their people to perceive and cherish their own environment in more valid terms. As Van Nieuwenhuijze writes: 'We still have to unlearn a considerable amount of ethno–centrism and of simplistic evolutionism, but we need not fear that our lesson will not be brought home to us.'[4] The machinery of international technical assistance and the centre–periphery relationship must be restructured if the potential of every African country in the developmental process for meeting their own basic needs is to be maximized.

Short–term adaptive strategies

Short–term adaptive strategies can be grouped under three main headings: (i) behavioural change, (ii) determination of priorities, and (iii) technical operations.

[4] A. O. C. Van Nieuwenhuijze, *Research for Development in the Mediterranean Basin: A Proposal* (The Hague: Mouton, 1961).

Behavioural change. Creating a more meaningful role for science and technology in national development requires vast changes in, and expansion of, education and training for all age groups and all socio–economic sectors of the population. Because the objective is to reshape behaviour along more socially constructive lines, the concepts taught should be directly and clearly related to the needs of the people, their resources, and the improvement of their productivity.

The existing pattern of education in most African countries helps to alienate educated citizens from their own society. It makes them cultural illiterates of their heritage and compels them to accept foreign values irrelevant to their society and culture. Therefore, education needs to be made inward– and not outward–looking, and under no circumstances must it seek to imitate Oxford, Cambridge, Harvard, M.I.T., Sorbonne or Lund. African educational systems must reflect the needs of the African societies in a changing world. Just as there is need for a technology appropriate to African development, so also there is need for an educational system appropriate to African development.

Determination of priorities. The first requirement is the careful identification of key problems that can be tackled by scientific and technological inputs. Equally important for development planning is the identification of what should not be done. Taking these steps would enhance critical and objective judgements in the selection and application of science and technology to African development. The forthcoming UNCSTD and subsequent international conferences could make a major breakthrough by examining first what should not be done in developing nations in the field of science and technology. By filtering out what should not be done and by identifying what can be adapted to the cultural heritage and environment of each developing country, these global forums would be much more likely to make a significant contribution to improving the human condition, which is what they profess to be about.

Technical operations. These involve choosing specific operational methods for implementing development plans, such as pre–investment and feasibility studies, project selection and evaluation, cost–benefit analyses and so on.[5] But these methods must be applied in such a manner that external flows of knowledge and technique are adapted to the cultural heritage of the society concerned: they must not be such as pervert its cultural heritage and values

[5]Robert Dorman (ed.), *Measuring Benefits of Government Investments* (Washington: Brookings Institution, 1965), pp. 208–226. For the developing countries, see A. O. Hirschman, *Development Projects Observed* (New Haven: Yale University Press, 1958), pp. 174–180; and also *The Strategy of Economic Development* (New Haven: Yale University Press, 1958).

in the process of development.[6] This has been the pitfall of Western methods and their application to development in Africa. When these methods fail, the general conclusion is drawn that the people, the society, are incurably 'backward' and must therefore remain forever dependent on the centre to solve their own problems.

Long–term 'reconstructive' strategies

African countries must strive for consensus and political commitment on long–term development strategies. Preparing for UNCSTD, UNCTAD, UNIDO, and the Special Session on the Third Development Decade provide an occasion to do so. African objectives around which a consensus is to be built up should be:

— to recognize the need for regional economic growth;
— to press toward the ultimate objective of achieving African unity – military, economic and political – which should strengthen intra–African trade;
— to further national self–reliance as well as collective self–reliance for the entire continent;
— to avoid social unrest and political instability by incorporating ethnic minorities in the process of nation–building while ultimately working towards national unity and a more equitable distribution of growth/wealth;
— to work for strength and unity within Africa so that the benefits of world interdependence can be equitably shared through negotiations from a strong bargaining position;
— to further technological awareness at home from the perspective of using and improving traditional technologies which will help to improve the lot of the majority of the society as against Western technologies which only increase Africa's dependence on the centre nations.

African countries should participate in these global events with the explicit goal of attaining a new and well–defined policy agreement with the rich nations, which will enable them to accelerate their own rate of economic and social growth on their own terms and which will set in motion the fundamental changes in policies of international cooperation in order that it may contribute to, rather than inhibit, this process.

There is every likelihood that the 'technological gap' between the North and the South will continue to widen as the pace of development quickens in the industrial world. But African leaders should resist the temptation to

[6] See Jens Muller, 'Choice of Technology within the Framework of a Development Policy', Centre for Development Research, IDR Paper A. 76.3, and A. 76.5, Copenhagen, Denmark.

become slaves of such industrial and technological complexity; it is by now abundantly clear that this is not the way to solve persisting problems of backwardness. Rather, modern technology should be sought only if it is adaptable to the social and cultural environment of the continent. If such a position is taken, it will enable the African states to limit the inroad of developed countries' products marginally relevant to African needs.

Science and technology in African development strategies

In implementing these short–term and long–term strategies, science and technology can play an important role, once the underlying economic and political framework and direction have been established. Here are some proposals which should be actively debated as Africa prepares for UNCSTD and other forthcoming international conferences:

(i) Create an African science corps through which the present handful of African scientists can be shared and enabled to contribute to national development throughout the continent.

(ii) Restructure the present set–up of the OAU and at the same time establish an African common market[7] and a common military defence organization.

(iii) Allocate a reasonable percentage of GNP for research and development on high–priority projects directly related to the needs of the poor.

(iv) Encourage local innovators through various award schemes for new or improved processes and products which contribute to the well–being of the poor.

(v) Establish joint research ventures and other forms of cooperation across national frontiers among research institutions and bodies of higher learning.

(vi) Strengthen the role of economic groupings like UDEAC, OCAM and the West African Economic Community in the choice, development, and application of science and technology to meet the needs of member–states.

(vii) Establish research policy institutes or sections as essential components of the developmental process in all countries or organizations like the OAU, UDEAC, OCAM etc. to analyse policy options and choices in science and technology and in other fields.

(viii) Redeploy some of the GNP allocated for the armed forces in such a way as to apply technological capabilities within the military to serve the

[7] John W. Forje, 'An African Common Market', *New Africa* — Trade with Africa — Supplement No. 3/4, London, 1969.

needs of the rural and urban poor. Thus, military engineering services can be employed as a vehicle of development in building roads and small-scale irrigation works; military personnel can assist in locally initiated land-development projects to grow more food; and military medical personnel can train rural medical practitioners to provide basic health care services to people of Africa as has been done in China.

African countries are not at war, not even the front-line nations bordering Rhodesia. The Ethiopia-Somalia encounter is no African war, it is an extension of the cold war and power struggle between the East and the West over the control of strategic areas important to both in the on-going race for hegemony.

Yet, a war is being fought, and no African nation can opt out of it: the war against hunger, poverty and underdevelopment. African soldiers must fight this war, not by polishing their boots and bayonets, but by working with and for the people. The armed forces of the African states must be properly employed in the process of nation-building and not for meeting and preserving foreign interests of exploitation and domination as is being done in the Shaba Province of Zaire.

Trade, aid and technology transfer

Raul Prebisch spoke, more than a decade ago, of the 'attainable minimum' necessary to attack the problem of persisting trade imbalance and of creating essential external conditions for accelerating the growth of the Third World under the following six main points:

— Primary commodities should be given easier access to the markets of the major industrial centres and be assured of a reasonable share in the growth of consumption.
— The purchasing power generated by export earnings of developing countries should be increased and stabilized, either by commodity agreements or by compensatory financing mechanisms.
— Restrictions presently hampering the entry of manufactures and semi-manufactures of developing countries should give way to a preferential policy, subject to a reasonable list of exceptions, to assist new industries in those countries in finding external markets.
— Import substitution must be encouraged and rationalized as far as possible, through the formation of groups of developing countries.
— Trade with the socialist countries on a long-term basis must be encouraged in order to move away from bilateral to multilateral arrangements.

— The burden of servicing external debt must be reduced by readjusting loan periods and terms, and by adopting measures to limit freight and insurance.[8]

To these six points must be added another: the transfer of technology along the lines recommended by the Group of 77 in the technology–transfer code–of–conduct negotiations under UNCTAD. African countries should pay for whatever imported technology they need and not seek technology channelled under aid assistance programmes with all their inbuilt failure mechanisms for the recepient countries due to the inappropriateness of the technology thus acquired. A country that goes out shopping with cash in hand stands a better chance of getting the right kinds of technology with fewer strings attached than one that goes out begging, as most African countries do. In such a situation, one is obliged to accept what is given without seriously questioning its appropriateness. But the effectiveness of shopping with cash payment hinges on the implementation of the steps proposed by Raul Prebisch so that they will have the necessary foreign exchange to purchase the technology they need. Equally important in shopping for technology is knowing what one wants and having enough technological awareness so that one can negotiate a fair bargain and not get cheated. Implementation of the national and regional proposals made here for strengthening Africa's science and technology base will help to achieve these essential preconditions for effective purchasing of technology without strings on the world market.

An interesting historical analogy is the case of Japan which did not receive economic and technical assistance on concessional terms and paid for all forms of imported knowledge. Japan also went about systematically creating its own experts by sending Japanese students abroad for training and industrial experience *with clearly defined goals*, which fed directly into the overall process of national development. These steps gave Japan far greater control over its national development, since it is common knowledge that experts coming from abroad and not paid by the host country normally take instructions from the countries from which they come and which pay them Today,

Japan is one of the few market economies which has managed to overcome problems of technological independence. Whilst there may be some doubts about the applicability of Japanese experience to other countries, the contrasts are interesting. Broadly speaking, Japanese policies seem to have been designed to create a complementary relationship between the import of foreign technologies and skills, and 'learning by doing' by local technologists. Government financed R&D expenditures in those industries which made use of foreign production techniques. The terms on which technologies were transfered were controlled so as to allow local engineers to learn from them, sometimes by reverse engineering, stripping down newly imported plant and machinery so as to learn how it works and, in some instances, to copy

[8]See Raul Prebisch, *UN Monthly Chronicle 1*, 1, May 1964, p. 87.

it. Direct control by foreign enterprises – as opposed to licensing contracts which did not involve control – was strongly discouraged. In general there appears to have been an explicit objective of using foreign technology as a basis for the development of local technical capability, rather than a substitute for it.[9]

Dependence is a central problem for many developing countries today. The only way out is to pay for services and equipment so that the recipient country can dictate the pace and direction of its national development effort.

Science, technology, global interdependence, and the New International Economic Order:

If the industrialized countries really believe that humanity has entered into a period of 'science and Technology in an Era of Interdependence', to cite the title of a recent superpower NGO publication,[10] then they must stop dictating the direction of development in the developing countries by forcing on these countries inappropriate technological goods and services. They must also be willing to pay for raw materials on equitable footing as developing countries now pay for finished products. UNCSTD and other forthcoming international conferences should also come to grips with the fact that the rate and character of technological change in the industrialized world is increasing its dependence on foreign sources of raw materials and energy to keep its factories producing at a high level.

Thus, global interdependence is a reality with which all nations must cope, even though the frequent proclamation of its desirability by rich country spokesmen masks serious inequities and persisting dominance–dependence relationships. This gives added significance to the growing role of science and technology as powerful instruments in the foreign policy of most developed countries.[11] For example, a recent study by the US Congress, *Science and Technology in the Department of States*, notes:

A feature of the world scene today is the complex way in which so many of the great global problems intersect. Materials shortages raise questions of political jurisdiction over the deep seabed .... In fact, directly or indirectly, most of the large technological issues facing the world of the future in 1975 appear to be closely interconnected. The implication of this demonstrated interconnectedness among international technological issues is that organizations cannot operate effectively if they are limited in scope to a particular function or issue. Coordination is essential to ensure that each mission organization, national and international, does not operate

[9]Charles Cooper, 'Science, Technology and Production in the Underdeveloped Countries: An Introduction', *The Journal of Development Studies*, Special Issue, Vol. 9, October 1972, p. 7.
[10]United Nations Association of the USA, Report of a National Panel, 1975.
[11]See John W. Forje, 'Science and Technology: The New Dynamite in Foreign Policy', paper presented to the Foreign Policy Association, University of Lund, 21 September 1977, Lund, Sweden.

at cross-purposes with other organizations with other related missions ... And, indeed, the extent to which the US Department of State is organized, equipped, and manned to coordinate U.S. aspects of these functions and issues is open to serious questions.[12]

This statement reflects the new line of thinking about the emerging role of science and technology in the foreign policy of the US. On the other hand, hardly any African country can boast of a well-staffed foreign affairs department, let alone one which addresses itself to the issue of science and technology as a major instrument in foreign relations.

If science and technology are becoming an increasingly important factor in international relations, following the present trend in most developed countries, then there is a real danger that science and technology will not serve humanity in a proper way, but will become more and more an instrument of destruction and domination. Therefore, it is essential for the forthcoming world conferences to create the necessary political awareness that will make possible in the 1980s the utilization of science and technology not as a means of maintaining centre–periphery relationships but, rather, of bringing about an international system characterized by 'equality in diversity'. It is essential for the industrialized countries to recognize through actual practice what they so often loudly proclaim, viz. that the survival of humanity depends on the extent of equality achieved by the developing nations and the degree to which their citizens are accepted as human beings on an equal footing with those in the industrialized world. 'The world in which we live is poised uneasily between an era of great enterprise and creativity and an age of chaos and despair', observed Henry Kissinger.[13] For once he may have been right.

Obviously, it is impossible to set forth a clear-cut global blue-print as the one and only answer to the problems posed by the crises of the 1970s in development and the international system. But we should make a determined effort to use the forthcoming world conferences as a means of moving beyond conventional thinking and bland diplomatic talk – such as the guidelines for the preparation of national papers issued by the UNCSTD Preparatory Committee, to confront underlying issues.[14] We should recognize that unplanned interdependence leads to continuing dependence and that human equality, not industrial differential, is the proper basis on which to create a new world order of science and technology for development. Similarly, the international community should recognize that a hungry person is an angry person, and that the developing nations will no longer tolerate the exploitative ways of the industrial world. The industrialized

[12]See Franklin P. Huddle, *Science and Technology in the Department of State*, 1974, p. 149–150.
[13]Henry Kissinger, 'The Global Challenge and International Cooperation', address at Milwaukee, Wisconsin, 14 July, 1975, circulated by *UNA*, New York.
[14]UN Economic and Social Council, Document E/C.8/L.84, 12 February 1977.

countries should not assume that the patience so far shown by the Third World will continue indefinitely.

To what extent and in what ways can these global conferences lay the basis for enhancing the bargaining position of the non–industrialized countries, so essential for achieving a constructive and equitable world interdependence? What steps are necessary in order to accelerate the acceptance of a new international economic order characterized by greater equality between the developed and the developing countries? What can be done to curtail the growing powers of multinational corporations so as to make it possible to achieve a balance between the interests of multinationals and local enterprises? What codes of law and conduct should be brought about to govern the behaviour of multinationals and to create a suitable basis for the emergence of local enterprises? What structural changes and practical approaches, regional or international, are needed to strike a proper balance between constructive economic interdependence and the growing protectionist attitude of some Western nations, or group of nations, such as the EEC or the COMECON?

For African countries, the central question should be: Does our relationship, through the Lomé Convention, lead to development in our own way? Or does it perpetuate the centre–periphery relationship? Is this the form of cooperation that can usher development? Would it be feasible to limit the present pattern of unequal partnership? What other options are there for us to follow?

Science, technology and Africa in the changing international system

The problem of planning Africa's scientific future is extremely complex and difficult. As Amilcar Herrera points out,

> Science planning is an attempt to control and direct an existing and, generally speaking, efficient and technological research system. The problem in the developing countries, on the other hand, takes a different form: scientific and technological systems in these countries are very limited, sometimes almost non–existent and scientific activities are almost totally unconnected with national problems. Consequently the fundamental problem in developing countries is not so much to improve the efficiency of an existing mechanism, but to build new systems frequently starting from almost nothing.[15]

Given this situation, the proposals for strengthening science and technology in implementing African development strategies offer a beginning. What is essential is the creation of the necessary institutions in Africa to serve basic needs of the people, because science and technology can only grow from

[15]Herrera (f.n. 1)

indigenous resources and local personnel. Science and technology are culture–oriented and tied to the traditions of the societies in which they are developed. Therefore, science and technology in Africa must develop from the embryo of African culture and heritage and must reflect African cultural values and social realities if they are to serve the needs of the African peoples.

There is no doubt that the threshold at which African countries stand is either of collapse or of a balanced, self–reliant development. This means that UNCSTD, UNIDO, UNCTAD and other forthcoming world conferences offer a real possibility of increasing international understanding of, and support for, a distinctively African approach to solving development problems. One critical advantage, as Louis Dupree points out, is that they,

> like others in much of the developing world, have a natural resource no longer available to the West: that resource is time. Neither Western, including Soviet, nor Western–trained advisers and technocrats understand the need to utilize this resource. But time is necessary for evolution, and evolution is necessary for the institutionalization of change processes. Confrontation among Great Powers and their interference in regional and transnational developme[illegible] preclude local use of time as a natural resource.[16]

The Third World in general, and Africa in particular, must learn how to exploit this resource to greater advantage.

This view of technology in international relations by two superpower scholars underscores the need for African countries to exercise restraint in embracing 'modern' technology which may be offered on concessional terms by the industrialized countries at these international conferences, because

> Modern technology means more than advanced machinery or electronics; it means human resources, a market, and a cooperative association among government scientists and industrialists. The resources of modern technology are lacking in all developing countries even among OPEC member countries as much as they are in the over–populated, oil–poor states of the Indian sub-continent and in Africa. The control of technological uncertainty is becoming as crucial to the prospects of modernization as the transfer of technology itself.[17]

The main obstacles to progress at these conferences will be nationalism and the desire of the developed countries to preserve the *status quo* in the international system. Nationalism, wrote Herbert Hoover and Hugh Gibson in 1942, 'has developed from the deepest of primitive instincts and emotional forces in mankind ... Nationalism can readily expand into dangerous forms ... but will continue as long as man inhabits the earth and will have to be embraced in any plan to preserve the peace.'[18] Nationalism, for Africa

[16]Louis Dupree, 'Imperialism in South Asia', *South Asia Series, XX*, 3, The American Universities Field Staff, Inc., June 1976, p. 6.
[17]William R. Kintner and Harvey Sicherman, *Technology and International Politics: The Crisis of Wishing* (Lexington Books, 1975), p. 110–112.
[18]Herbert Hoover and Hugh Gibson, 'The Problems of Lasting Peace', in Preface to *Peace: A Symposium* (New York: Simon and Schuster, Doubleday, Ryani and Hitchcock, and Colombia University Press, 1943), p 160–161.

and the rest of the Third World, as for the industrialized countries, can be as much a creative force as a motivation leading to destructive behaviour through attempts to dominate other nations. As far more powerful, both politically and economically, it is for the industrialized countries to strive harder to channel their nationalism along constructive lines in the interest of genuine world interdependence.

Unfortunately, 'interdependence', from the point of view of the developed countries, has more often than not meant their dominance over others. Hence the confrontation today between the developed and the developing nations, as reflected in the North–South negotiations on the New International Economic Order. The developed countries have, by and large, refused to consider seriously the views of developing countries. They have failed to bear in mind that, in spite of their level of industrialization,

> no country in the complex technological and political world of the present day is completely self-sufficient in the raw materials consumed by its people. Even the so-called 'supplier' countries in their turn need materials from other countries. This inter-linking of availabilities and necessities is the most profound reason to mount an effort to resolve the problem of world materials supply by interdependence within international justice.[19]

Since economic nationalism is part and parcel of political nationalism, it is not surprising that the industrialized countries seek to bend the Third World to further disadvantage through the manipulation of the supply and the prices of raw materials from developing countries while increasing the prices of finished products exported by the industrial nations to the developing countries. Transfer of technology which is not geared to the direct needs and requirements of the developing countries is a major factor in maintaining this pattern of exploitation. Therefore, it is essential for the developing countries to start rejecting Western ideas of progress patterned on Western technology. Here, as we have noted, African countries have a marked advantage over the rest of the Third World since they are less hooked on 'modern' Western technology. This view has been strongly stated by Mahbub ul Haq in these words:

> ... the Third World must return to consider the needs of its land and people first ... the real question [is] not whether the Third World [has] a future, but whether the industrialized western world [has] a future. In the next twenty-five years, the economic, financial and cultural balance of power will be shifting to the Third World.[20]

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[19]Edmundo de Alba, Scientific Councellor, Mexican Embassy, in a speech at the August 1974 Conference at Henniker, New Hampshire, on 'National Materials Policy Requirements'. See also US Congress, Office of Technology Assessment, 'Requirements for Fulfilling a National Materials Assessment', Franklin P. Huddle (ed.).

[20]Quoted in Thelca R. Fabian, 'Does the Third World have a Future?', Report on a workshop of the Second General Assembly of the World Future Society, held in Washington D. C., June 2–5, 1975. *Newsletter of the International Society for Technology Assessment, 11*, 2, Summer 1975.

It is the fear of this ultimate shifting of global power and the recognition of the growing dependence of industrialized countries on energy and raw materials from the Third World that promoted Henry Kissinger to propose at the Seventh Special Session of the UN, and again at UNCTAD IV, the creation of an international industrialization institute and international centre for the exchange of technological information, voluntary standards of conduct for both governments and multinational corporations with respect to the operations of the latter, adjustments in the relationship of the developing countries to the world trading system, establishment of a consumer–producer forum for every key commodity, and a major new international effort to expand raw material resources in developing countries.[21]

These Kissinger proposals underscore the need for a readjustment in the thinking of the rich nations such that they may not cling to the present *status quo* but create some elbow room for African and other Third World countries in the management of the international system. The proposals also indicate the extent to which science and technology have become key factors in the operation of that system.

In the final analysis, for the African countries as well as for other nations, UNCSTD and other forthcoming world conferences should provide opportunities to open up new perspectives for both the developing and developed nations to face on equal footing the many problems confronting humanity today. The consensus achieved must be based on human equality and justice and not on inequality and exploitation which have prevailed for too long. With the help and guidance of experts from many nations, but above all with their own experts as the mainstay, developing countries can design their own means of development, not through the old practice of bypassing their cultural heritage, but through incorporating it as a motive force in the continuous process of economic and social change which occurs within all societies. Hence the overriding principles guiding UNCSTD must be conjured up from the premise of 'Ask not what science and technology can do but what each individual nation is prepared to do for the other on the basis of human equality, social and international justice, and from the postulates of interdependence across national frontiers.'

[21]Henry Kissinger, 'Global Consensus and Economic Development', (Washington, D. C., Department of State, Bureau of Public Affairs, Office of Media Services, September 1, 1975). This speech was delivered in the UN on behalf of Secretary of State Henry Kissinger by Ambassador Daniel P. Moynihan.

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THE TRADITIONS OF TECHNOLOGY*

Ashis NANDY†

Modern technology is a particular form of traditional technology with about 300 years of history behind it. It has become the dominant tradition by marginalizing the other traditions of technology in the West and in the rest of the world. In this marginalization, important roles have been played by the ideology of Englightenment, by the Industrial Revolution, and nineteenth and twentieth century colonialism. They have blurred the difference between science and technology, underwritten the mechanomorphic world-image and promoted the concept of a value-free, ethically unrestrained technology seeking omnipotence and omniscience on behalf of man. However, the present crises of technological consciousness has brought to the fore alternative traditions of technology, not as ethnotechnologies from which a universal, secular, modern technology can draw lessons, but as competing philosophies of universality which can provide correctives to the alienating, exploitative, and dehumanizing role of modern science and technology. For this, an alternative ideology of science as well as a new legitimacy for the traditional technosystems and their cultural environments is necessary. Such a legitimacy will have to be based on a different set of values relating to the man–nature and man–man relationships and a deeper understanding of the politics of technology in its cross-national and cross-cultural contexts.

I. The tradition of modern technology

If the Englightenment and the Industrial Revolution are given the credit for helping modern science and technology to grow, they must at the same time be held responsible for breaking down the definitional boundaries between science and technology. The legitimacy that science began to earn in the seventeenth century was mostly derived from the technological achievements of the Western world. Though historians of Western technology are

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now more or less agreed that modern technology owes its growth not to science but to prior technology,[1] the myth was gradually promoted that the growth of science was inextricably linked with the growth of technology and neither could be separately pursued. Previously, scientists in the West did not enjoy a high social status; but, taking advantage of the euphoria generated by the new technological break-throughs (from the Elizabethan circumnavigations of the world to the inventions reported in the evening meetings of the early Royal Society to the steam engines earnestly fumigating the European landscape), a new estate of science-and-technology was created, which ensured its members new prestige that neither the scientist nor the technologist could previously dream of acquiring by himself. The concept of the scientist as a slightly seedy natural philosopher and practitioner of an esoteric discipline, and of the technologist as a humble craftsman gradually underwent a change. Both became partners in a new high-paying heady enterprise called modern science.

Secondly, though the term 'world machine' had come to be used more and more in Western Christendom since the beginning of the thirteenth century, it was used in a favourable sense. At any rate, Lynn White reminds us, the expression used to refer not to the earth but to the skies. Things began to change in the early decades of the seventeenth century. As White describes it,

> In 1610, ... Galileo built an improved telescope and found spots on the sun, mountains on the moon, and satellites wheeling around Jupiter. He thus unified celestial and terrestrial physics, but instead of demechanizing the sky, he ended by mechanizing the earth. His younger contemporary, Descartes, included in this mechanization all animals; to him, and to millions who fell under his influence, they were insensible machines who despite superficial evidences of joy or agony, had neither minds nor feelings. Only human beings had such characteristics. ...
>
> Then it became mankind's turn to be mechanized . . . Darwin made man completely part of nature. There should have been nothing surprising about this. If we can believe anthropologists and the historians of non-Western cultures, most people in most times and places have thought of themselves as being such, and have found sustenance in the idea. The trouble among Westerners was that by the twentieth century the late-medieval emphasis on the importance of matter, and on mathematics as the only basis for rational certainty, had created a lifeless and impersonal image of 'nature' with which few wanted to be identified.[2]

It has been a long walk from Galileo to the present-day protests against mechanomorphism and unlimited technology. On the way, the human ex-

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[1] e.g., see D. J. Solla Price, 'Is Technology Historically Independent of Science? A Study in Statistical Historiography', *Technology and Culture* 6, 1965, 553–568. See also an interesting attempt to provide a philosophical background to this historical difference from a non-Western perspective in A. K. Saran, 'The Traditional Vision of Man', Paper presented at the UNESCO and ICSSR Meeting of Experts on the Impact of Science and Technology on Cultural Values and the Quality of Life in Asia, Hyderabad, India, September 1978.

[2] Lynn White, Jr., 'Science and the Sense of Self: The Medieval Background of a Modern Confrontation', *Daedalus*, 107, 1978, 47–59.

perience called science has liberated Western technology from most social and cultural constraints and allowed the principle of 'technology for technology's sake' full play. So much so, indeed, that the remedies against the ills of technology today are mostly sought in technology itself. For a long time, the principle was seen as a harmless extension of the slogan 'science for the sake of science'. European intellectuals, fighting for autonomy from the medieval church and defending science against the theological accusation of its being a runaway science, overconcerned with nature as opposed to the pure contemplation of God, had no reason to suspect that technology could really go haywire. Nor could they believe that, unlike a rabid science which at worst is a misguided philosophical venture, a rabid technology could have immediate impact on social relationships and human self-image, reducing man's autonomy and authenticity in his self-created world.[3]

This struggle to protect secular knowledge and secular techniques in the name of rationalism dominated the Western world-view till recently, making the latter increasingly mechanomorphic and justifying attempts to reconceptualize and rebuild man himself in the image of his most successful creation.[4] Finally, today the mainstream culture of technology, though apparently organized around a value-neutral concept of instrumentality, has become the model of all valued cultures and being-states.[5] At one time tools were seen as a substitute for hands; they have increasingly become a substitute for brains. In fact, in the modern sector, the indicator of good technology is the extent to which it makes the most distinctive aspects of human beings redundant.

Thirdly, while in all societies techniques are to some extent associated with power, it was only in the seventeenth century in Western Europe that science and technology became clearly identified with power, activism and aggression and, probably because of this identification, with the masculinity principle in the Judeo-Christian cosmology. It was at this time that societies in the throes of the Industrial Revolution, or under the influence of the revolution in nearby societies, 'saw' in their religious system what Lewis

[3]Recently, Robert Sinsheimer has called this process the certainty principle, the inverse of the uncertainty principle. The uncertainty principle is concerned with the impact of the observer on the observed; the certainty principle, with the expanding area of certainty and the inevitable influence of the observed on the observer. See his 'The Presumptions of Science', *Daedalus*, 107, 1978, 23–35.

[4]Rolland Barthes in his 'The Brain of Einstein', *Mythologies* (New York: Hill and Wang, 1976), pp. 68–71, gives a brief but telling example of the ways of thinking associated with this orientation to the world.

[5]I can find no better example of this than the 'inner speech' of behaviourism which, through the concept of operant conditioning, has reduced individualism to the principles of a biophysical machine. In the age of the psychological man, some psychological men can be very non-psychological.

Feuer has called a 'divine sex change'.[6] As a belated consequence of Protestantism, some of the European Christian traditions began to de-emphasize the imagery of the mother of the God and the feminine – or rather maternal – elements in the cosmos as a part of sacredness. Simultaneously, with the decline in the so-called magical perspectives on the natural and interpersonal worlds, there was less fear and awe of women and of their magical powers than had found expression in the great medieval witch-hunts. The European personality was now more confident in its Christianity, less fearful of its pre-Christian pagan self,[7] and more secure in its belief that God the clock-maker and the super-engineer was also a hyper-masculine patriarch. The supra-human saints and witches were now in decline, and Europe's Christianization was now complete. The charisma that was wrested away from nature and humanity (once, even though a mere human, you could be a miracle worker as saint or witch) was now reinvested in the person of a monopolistic, omni-*potent* and omni-*scient* God who, in response to your this-worldly work, productivity and masculine self-affirmation, rewarded you with a share of His potency and science. The secularized versions of this patriarchal religious ideology assumed a divine Father whose insecure male children would find masculine self-expression in imperial and colonial conquests, on the one hand, and in the doctrines of scientism and technologism, on the other.

There was another cultural process at work at the time which seemed to contradict the foregoing. But its results were the same. It was only in the seventeenth century that Europe's contacts with distant cultures and their sciences began to deepen, mainly due to improved transportation and an emerging global perspective to science. This exposure to other sciences negated some aspects of the Christian cosmology. (For instance, exposure to Chinese astronomy conclusively showed that there were recorded eclipses that antedated the Genesis.) Already in conflict with Christian theology, European science found in these new experiences an ally against religion, but the European scientists were still men of faith, unwilling to give up their textual Christianity. They ended up by splitting their religious consciousness from their scientific consciousness and by trying to pursue faith and science separately. As a result, the moral control which religion had imposed on knowledge and techniques dramatically diminished. Admittedly, this control had been wielded by the Church in a bigotted, petty-fogging and churlish fashion, and certainly rather inefficiently. But it had provided a framework, however crude, for a moral science. The new schizoid orientation to science separated the spheres of morality and science, and left the

[6]See Lewis Feuer, *The Scientific, Intellectual and Sociological Origins of Modern Science* (New York: Basic Books, 1963).
[7]Norman Cohn, *Europe's Inner Demons* (New York: Basic Books, 1975).

latter free to define its own ethics in terms of the needs of science and the secular demands of the individual and the state.[8]

II. The other tradition of the West

Seventeenth century science and technology was a heady enterprise. For more than a century, there was little concerted dissent from the mainstream culture which underwrote the adventure called science. But there were acute self–doubts subsequently in the West itself in different phases of the growth of modern technology. The early critics of the Industrial Revolution and the emerging technocratic civilization – such as William Wordsworth, Percy and Mary Shelley, and Thomas Carlyle in the first half of the nineteenth century – were also the most trenchant. Some of them sensed that tools were only an extension of man and the romance of technology was only another version of the romance of existing social institutions.[9] Marx, who never truly lost his innocence and awe about modern science and technology and who was willing to grant them the status of independent variables in social causation, was nevertheless clear in his mind about how technology could be used to underwrite faulty social institutions in the short run. Others like Wordsworth almost intuitively rejected the diminution of the communion with, and the direct experience of, nature. His contemporary Mary Shelley expressed the inchoate fears of the growing power of technology and the technologists by popularizing her private phantasies about technological pathologies into what soon became an important shared myth. It was not an accident that the name of her mythical maker of a monster, Frankenstein, quickly became in popular imagination also the name of the monster – a transferred epithet again hinting at the vague awareness that man's techniques could not be separated from his selfhood. In other words, there had persisted in the West an alternative percept of technology which refused to compromise with the dominant technological consciousness. It was this recessive tradition that social critics like John Ruskin and Leo Tolstoy drew

[8]cf. the position of Jurgen Habermas that 'Technocratic consciousness reflects not the sounding of an ethical situation, but the repression of "ethics" as such as a category of life', 'Science and Technology as Ideology', in *Toward a Rational Society*, translated by J. J. Shapiro (London: Heinneman, 1971). A slightly different but compatible verson of the same story explains the changes in European scientific consciousness in terms of 'a new hierarchy of the sciences by a structural inversion of the old European hierarchy of God, man and nature'. See Jit Singh Uberoi, *Science and Culture*. (Delhi: Oxford University Press), forthcoming.

[9]a point which Bruce Mazlish has made in a slightly different way in his 'The Fourth Discontinuity', *Technology and Culture*, 8, 1967, 1–15.

upon, formalizing these vague dissatisfactions with modern science and technology in the West into an articulate alternative utopia.

When the First World War came, it confirmed, for at least some Western intellectuals, their worst suspicions about a fully autonomous technology. For a while there was a retreat from, and fear of, reified, free-floating technics taking over the world and shaping human destiny. Karel Capek's play introducing the robot was published in 1920, and its tone dramatically expressed mankind's anxiety about the dionysian face of modern technology. The Surrealists, of course, went further in Andre Breton's manifesto (1924). Drawing upon the Freudian vision of man, they rejected not only the basic values of science and technology, but also everyday rationality and all organized knowledge. The flip side of the anxiety these men reflected was the primitivism of D. H. Lawrence and the anti-thereapeutics of George Bernard Shaw, one bemoaning the loss of man's 'natural' self, the other the loss of man's dignity and autonomy in the hand of 'expert' technicians.[10]

There were also attempts, sometimes half-hearted and sometimes earnest, to discover an alternative concept of science and technology in the works of Eastern scientists, mystics and social philosophers. It was at about this time that men like Okakura, J. C. Bose, Ramanujan, Tagore, Aurobindo and Gandhi became mythopoeic and cult figures among some in the West. Actually, only a small part of their appeal was based on an appreciation of their work; the larger part drew upon the spreading anxiety about losing touch with those aspects of the Western civilization which these non-Westerners seemed to represent. They looked self-confident and self-actualizing allies of pre-War intellectuals like Tolstoy and Ruskin and post-War figures like Romain Rolland, Aldous Huxley and Albert Einstein, all of whom mirrored, in different ways, the recessive elements in the Western orientation to technology. Even from within the confines of positivism came impassioned attacks on the culture, if not the content, of technology. Bertrand Russell's choice of the title *Icarus* for his book on the future of science was itself an indicator of this consciousness. When G. H. Hardy, the ultra-positivist mathematician, said that applied mathematics was 'repulsively ugly and intolerably dull' and refused to lend his mathematical skills to the British war machine, he too was articulating a widely shared, if vague, vision of the dystopia to which technology was leading the human civilization and its proudest product, contemporary science.

The Western scientists and lay consumers of science suffered, after the Second World War, another acute bout of self-doubt – primarily precipitated by the growth of nuclear weaponry. This episode is so well known and

[10]A charming expression of such fears in the early parts of his century was George Bernard Shaw's depiction of doctors and their therapeutics in a number of his plays. See particularly *The Doctor's Dilemma* (London: Constable, 1911).

recent that I shall not discuss it here. However, one point needs to be made. The post–nuclear phase of self–doubt did not immediately initiate any attempt to return to the traditional Western concept of science or to alternative concepts of technology, as had happened after the First World War. Perhaps the older concept of science had been buried deeper in the Western 'unconscious'; perhaps by this time technologism had further consolidated its hold on the Western man. Either way, the main effort this time was to create a climate within which one could develop and use nuclear technology for peaceful purposes. That is, the identifier of the new technological consciousness became an alternative techno–ethics rather than an alternative technology.

It is only in the 1970s that the principles of the autonomy and primacy of technology have been challenged by what, according to many, is a world energy crisis, by a more organized environmentalism and by the concept of a techno–ethics which goes beyond the benign use of technology to the problem of limiting technology itself. No longer are we that confidently calling upon technology to solve human problems created by technology. At a period of history when in some societies two–thirds of all illnesses arise from the side–effects of drugs, when the destructive technology of armaments has overtaken the constructive technologies in financial outlays and man–power and is prepared to save the world by snuffing out mankind thirty times over, when the proportion of person–to–person communication in human communications has dropped from about 90% to about 10% within 50 years in some cultures, the tradition of modern technology does not seem that sacrosanct, nor does the idea of limits on technology seem an encroachment on academic freedom or progress of knowledge. In fact, the theories which vested rationality in techno–systems and technicians – and withdrew it from other human beings – lie in fragments around us, unable to cope with the fact that technology today has become a major bastion of irrationality, apart from being a major eyesore. It is only in our times that a creative film–maker like Jean Luc Godard can think of a cinematic climax in which the world ends neither with a bang nor with a whimper, but with a traffic jam.

The civilizational issues posed by this phase of galloping technological growth are yet to work themselves out fully; but it is obvious that the old concept of a value–neutral technology being operated by a gang of despicable politicians and subservient scientists is giving way to the awareness that the content of technology itself, in addition to its culture, economics and politics, is faulty. Wars, depressions, unemployment and ecological devastations no longer seem aberrations in the history of technological growth or the results of mishandling modern technology; they seem to be written into the technologism promoted by the Englishtenment and the Industrial Revolution.

III. The encounter of traditions

It is against these cultural and psychological experiences that one must view the traditions of technology and the choices before the Asian societies today.

In many of these societies, science has traditionally enjoyed a much higher status than most forms of technology. The literary cultures in these societies generally looked down upon technology as an inferior form of activity, involving low-status intervention in the real world of things and people. In Hindu society, for example, the social status of the Brahmins, interpreting nature and the macro- and micro-cosmos of science, was much higher than the status of the artisan castes, seen as lowly makers and manipulators of things. Theologically, too, the Hindu goddess of learning, Saraswati, is a first-order deity, whereas the god of technology, Vishwakarma, is a minor second-order deity. A roughly similar situation obtained in China. Technology, according to the dominant subcultures in these societies, was too concerned with becoming and too little with being. It was too manipulative, too obviously power-seeking. Some tool-wielders seemed to share this self-image and tried to impute vitalistic spirits into their machines, as if to humanize their techniques.[11] Science, on the other hand, seemed more contemplative and, thus, purer, closer to sacredness and 'high-cultural'.

This would seem to be the reverse of the European experience which I have outlined above. In one case, nature and man were mechanized; in the other, machines, techniques and implements were anthropomorphized. Later on, thanks to the West's military, economic and political paramountcy, the former was to become an indicator of civility, progress and modernity and the latter an indicator of pagan obscurantism, retrogression and sheer cussedness. But more about this later.

When towards the middle of the early nineteenth century colonialism began to nurture for its own needs a theory of imperialism – derived from the doctrine of progress already triumphant in the West – it introduced into many Asian societies modern science and technology as a prop to the colonial political economy and as an expression of its civilizing mission. The

[11] An interesting exploration of this theme in the modern context is the late Ritwik Ghatak's famous Bengali movie *Ajantrik* (based on a well-known short story by Subodh Ghose) in which an old car gradually becomes an anthropomorphic reality for the hero, a small-town taxi-driver. Elsewhere I have described the same process in a major Indian scientist of the inter-war years. See my 'Defiance and Conformity in Science: The World of J. C. Bose', in *Alternative Science: Creativity and Authenticity in Two Indian Scientists* (New Delhi: Allied Publishers), in press.

This is the inverse of the situation Chaplin explores in *Modern Times*, in which the hero himself gets increasingly mechanized as a result of his participation in a technocratic civilization. This theme has been discussed in elegant detail by Joseph Weizenbaum, *Computer Power and Human Reason* (San Francisco: W. H. Freeman, 1976).

theory of imperialism, as opposed to the fact of colonialism, heavily depended on the belief in the primacy of Western science and technology. Western technology being superior to the oriental technologies, so ran the theory, Western science and philosophy of science too were superior to their Eastern counterparts. This position was a natural outcome of the blurred boundary between science and technology in the West and the growing use of Western science as a secular justification of Western dominance.

So the search for a more modern world–view gradually became, in colonial and semi–colonial Asia, an attempt to supplant the existing techniques and, because neither the colonizers nor the colonized perceived the continuity between man and his tools, an attempt to supplant the existing man–nature systems.

The intersection of these two forms of technological consciousness – one Western but seen as universal, and the other Asian and therefore seen as particular – is reflected in the recent search in parts of post–colonial Asia for a technology that would be culturally meaningful and institutionally viable. The growing status of traditional technology among the urban middle class Westernized literati in South Asia is an extension of the soul–searching which has gone on in the West for a long time and of the crisis in the Western man–nature system that has now been telescoped in the Third World. As the representatives of the sector exposed to the dominant techno–ethics of the world, it is the Third World elites, not the Third World societies, that have discovered traditional technology in recent years. Actually, the latter did not need to be discovered; traditional technology has been, and still is, the dominant technological mode in most societies in this part of the world.

A part of this interest in traditional technology is no doubt an offshoot of what Rajni Kothari has called the new white man's burden: the recently cultivated and inspired interest in the West for the poor and oppressed of the Third World for whom the Third World itself, steeped in ahistoricity and oriental despotism, is unable to care. 'Modern technology for the West and Gandhism for the Third World' has been suggested as an apt slogan for this new concern for the non–West. But such ploys, and all the duplicity involved in the promotion of alternative technologies in the Third World, cannot detract from the fact that Western technology is unethical, alienating, over–organized, exploitative, hierarchizing, regimenting and dependency–promoting, not only in the general context of the globe, but also in the specific context of the West.[12] It is unlikely that its psychological and social impact would be different in the East.

[12]An excellent discussion of this theme is in Johan Galtung, 'Towards a New International Technological Order?' Paper presented at the Poona meeting of the World Order Models Project, July 1978, and being carried in this issue (pp. 277–300)

However, societies resist being taught; they prefer to learn on their own. It is improbable that the Western experience will deter us from further mechanizing man and investing the machine with greater charisma. The West's illnesses created by the machine are too distant, its gains from technology, measured in terms of power and wealth, too obvious. Our sufferings due to dependence and poverty, on the other hand, seem real and immediate, and the dangers posed by modern technology in the Third World seem abstract and hypothetical. Nonetheless, I see three interrelated perspectives which have set the stage for a rediscovery of traditional technology in some post–colonial societies.

First, the rich world of traditional technical knowledge, and the complex philosophies of science associated with it, is gradually unfolding before us as a result of the efforts of a variety of ethnoscientists.[13] We are at last moving away from the view that traditional technology is an avoidable anachronism, an evolutionary freak in a progressive scientific estate. Till recently, many traditions of technology were allowed to languish or die because of an arbitrary shifting concept of modernity.[14] Many societies were witness to a crucial process ignored in social studies of techniques – namely, the *detraditionalization* or demythification of individual techniques. Such a process may seem irrelevant in the context of the Third World, where the old technological world–view often coexists with its modern counterpart. But there are exampls of how this process of demythification goes on all the while, even in the backwaters of Asia. I am grateful to V. Padmanabhan for pointing out to me that the *charkha*, the traditional spinning wheel of India and perhaps the most remarkable example of an ancient technique becoming an instrument of social change and a symbol of an alternative polity in our times, had been delegitimized and made obsolete when the city–bred, Western–educated Gandhi 'artificially' resurrected and sanctified it as a technique with a new range of cultural, political and economic meaning.

Substitute the world 'traditional' by the world 'old', and examples of such

[13]For a brief introduction, see Michael Howes, 'The Uses of Indigenous Technical Knowledge in Development', Paper presented at the workshop on 'Indigenous Technical Knowledge', Institute of Development Studies, Sussex, April 1978, mimeographed.

[14]Some of the most creative scientific and technological traditions have been long neglected in spite of the fact that an important part of the so–called modern system is built on the products of such traditions. To give a well–known example, the image of the modern world as we know it is based on three technological innovations all of which were parts of traditional technology in China: paper, gunpowder and the compass. The modern world picked up these discoveries and made major symbols out of them, ignoring, till quite recently, the tradition of technology which produced them. A recent attempt to discuss some of the Asian assumptions underlying traditional technological intervention in nature is Seyyed Hussein Nasr, 'Asian Cultures and Modern Technology: The Oriented Attitude Towards Nature', Paper presented at the UNESCO and ICSSR Meeting of Experts on the Impact of Science and Technology on Cultural Values and the Quality of Life in Asia, Hyderabad, India, September 1978.

demythification will be found in the West too. Take, for instance, the many Western craftsmen hand-producing their wares and selling them through select outlets to the prosperous few. An old technique is here trying to survive as an art form, not as a less popular 'normal' technology. Similarly, the Western naturopath struggling to survive in the world of health insurance, hospital care and electronic medical technology is in some ways an example of the same process. There is, it is true, a touch of magic and necromancy in his occupation and in what his patients seek from him. But the magic no longer includes the sanctity given by traditions; it is not part of a life-style. The naturopath, as much as the potter, represents in the West an exotic technology, not a traditional one. Their specialists have been detraditionalized – secularized, if you like – by their societies.

The obverse of this process is the sanctification of certain concepts of technology. In many parts of the world today, 'modern', or what large parts of the world have come to view as 'the best of all possible technologies', has itself been *desecularized* and has begun to operate in a cultural milieu which is supportive and sustaining. Modern technology has not merely monopolized the status of a universal culture-free technology, it has become self-justifying, transcendent and an end in itself.[15] Such technologies as, for instance, specialized medical facilities, gadgets and personnel (in the place of general practitioners or family doctors), energy-guzzling industries, personalized transport systems, human engineering as seen in advertisement campaigns and in the management 'sciences' in general – are all parts of the traditional technology of North America and West Europe today; they have three hundred years of cultural history behind them, and have been, to use the anthropologist's term, ritually neutralized and integrated in the culture.[16] In the United States today, solar-energy-using devices represent an alternative technology. The situation would be reversed in a society where solar energy, or some such man-in-nature rather than man-over-nature technique, is the historical mode. There the dominant technology is the one which goes by the name of 'traditional'; the alternative fossil-fuel-using technology is what one would call modern technology.[17]

[15]It seems an attempt has been made by Hans Jonas to differentiate modern from ancient technology in terms of the dialectical relationship between ends and means in the first case and a unilateral relationship between ends and means in the latter. See S. R. Carpenter, 'Developments in the Philosophy of Technology in America', *Technology and Culture 19*, 1978, pp. 93–99. Perhaps Jonas means that ancient technology was an end too, whereas modern technology is only a means. I wonder if this differentiation holds any longer in the West.

[16]Unlike the hero of *Ajantrik*, it is no longer necessary for the American car freak to anthropomorphize his car. He can attribute to its magicality because it is a machine. The car has charisma because it is a super-machine, not a super-man, to its American admirers.

[17]What I am trying to convey is that the content of a technology does not automatically make it traditional or non-traditional. It is the element of sanctity or intrinsic legitimacy which a technology enjoys and, of course, its location in a culture or a life-style, which determines its traditionality.

Second, the dichotomy popularized by structural–functionalism which sees modernity as ineluctably opposed to the traditional is becoming unfashionable. It is becoming obvious even to the layman that modernity is only a secularized euphemism for Westernness and certain dominant strands of consciousness within the Judeo–Christian tradition. Seen as an idea of technology, it is just another form of tradition, presently dominant on a global scale because of the inequitous distribution of political and economic power in the world. It is this *tradition of modernity* which the present scientific and technological world–views have been trying to fob off on the rest of the world with the help of the doctrine of progress *à la* Vico, Hegel and Marx, on the one hand, and Locke, Hobbes, Bentham and Mills, on the other. In reality, *the choice is not between traditional and modern technologies; it is between different traditions of technology*, some dominant and some recessive, some appropriate and some inappropriate, some endogenous and some exogenous.

This is not to deny, but to stress, that in each culture some traditions are *contemporary* and relevant, and others are not. The tradition of modern techniques, for instance, was rational and useful in some cultural contexts. Who can deny the role of modern techniques (the printing press, for instance) in the struggle against medievalism in Europe? Is it possible to over–estimate the contribution of public health measures to the quality of life in many African and Asian Societies? But the same tradition today has posed a major danger to mankind because of three interrelated assumptions that it makes. Each of these assumptions has ceased to be valid. The assumptions are: (i) There is an in–built elasticity in nature which restores the natural system after man has intervened in it (the assumption has been negated by the scale and power of human intervention in this century); (ii) Nature is not only man's antagonist and technology a power against it; nature must be mastered or defeated rather than cajoled (negated by the possibilities of total defeat of nature in this century); (iii) The frontiers of technology must be constantly extended and, research–wise, whatever could be done must be done (negated by dangerous visions of the future ventured in recent times by many of the sciences themselves). The reverse of this process can be seen in someone like Gandhi who, in the thirties, spoke out against uncontrolled industrialization and urbanization, against Western education with its specific orientation to machines, productivity, consumption and nature, against the wholesale rejection of the attitudes towards nature and society identified with femininity and primitivism in the West, and against making population control a condition rather than a correlate of social change. At that time he was considered by many 'progressives' to be hopelessly outdated, even if lovably so. Times have changed, and the world–view that at one time seemed so anachronistic now seems remarkably contemporary.

Thus, the search for, and use of, traditions need not be a return from the contemporary world or another name for revivalism or nativism. The old is not always beautiful because of its antique value or because it counters feelings of national inadequacy. It becomes beautiful because of its continuous relevance and because it enlarges the area of humane technology. The search for traditional technology, too, is a search for alternative frameworks of values or world–views associated with technologies. It is an attempt to caputre the 'magic' – legitimacy, if you want to sound practical – that allows one to choose, reject or reconsider technologies in terms of criteria which are not merely technical.

This tame formulation brings us to the third element in the contemporary consciousness of technology which has made us aware of the technological traditions of the Third World – namely, that traditional technology represents a form of technology that is embedded in the culture and psycho–ecology of a community. What identifies it is not the technical content but the beliefs, values, symbols and myths that are associated with it. This is not an attempt to psychologize the problems of tehnique. It is a plea to recognize that techniques *qua* techniques cannot be called modern or traditional, and that techniques traditional in one society need not be so in another. Village technologies in general might be considered traditional in Bangladesh, and anyone interested in urban ekistics would be marginal in that predominantly rural society; but next door, in India or, for that matter, in Pakistan, such a stand would amount to ignoring the three–thousand–year–old tradition of urban living and urban architecture dating back to the Harappan period. Similarly, some techniques may be more deeply entrenched in a culture and some techniques may be easier to prise out of their cultural setting. But in each case, assessing a technique is also assessing its implicit cultural code and, ultimately, its normative presumptions.

IV. The legitimacy of traditional technology

Finally, the matter of techno–ethics. The openness to traditional technology presumes, as I have already implied, that those who live in the traditional sectors of a society do not have primitive or inferior categories of thinking which must be eliminated with the help of modern categories and progressive technological knowledge.[18] It is impossible to legitimize traditional techniques as valid alternatives without granting legitimacy to alternative

[18]See H. Y. Mohan Ram, Jit Singh Uberoi, Ashis Nandy and Ali Baquer, 'Ethno–Agriculture: A Research Proposal', Centre for the Study of Developing Societies, Delhi, 1978, mimeographed.

traditional ways of life. All cultures have ethnosciences and ethnotechniques which, in the context of those cultures, are rational and functional, if not in detail, then at least in overall conception. The rationality and usefulness of specific traditional techniques must be sought within the context of this overall rationality and function – that is, within what Claude Alvares calls the algorhythm of the technosystem.[19] Such openness to a plural concept of science and technology presumes that there is nothing romantic about traditional techniques and that a community has as much right to detraditionalize some of its age-old techniques as to traditionalize – orthogenetically transform, in the words of Robert Redfield – new techniques.[20]

Secondly, the very concept of traditional technology has come to mean, at least in most of the Third World countries, a compromise with a less modern technology and a shift to alternatives for reasons of capital scarcity, energy crisis, or attempts to move away from an élitist, large-system-dominated model to a village-centred political economy oriented to the rural poor. This is patently absurd. If harmony with natural and human environments is seen as a criterion by which technologies are to be judged, traditional technology is obviously neither marginal nor 'scientifically' flawed. Moreover, in most Asian societies traditional technology remains the basic technological substratum, covering sometimes as much as 85% of the population. To relegate it to the status of an alternative for the mythical 'dominant' modern technology, just because the latter is more visible in the urban areas, in the political centres of these societies, or in the organized industrial sector, is to close our eyes to the fact that traditional technology is still the mainstream technology which modern Western technology is trying to supplant in the name of a doctrine of progress which is not only marginalizing but also often irrelevant to the life-styles of the majority.

From this it is but a short step to the recognition that its embeddedness in a life-style is what gives every traditional technology its distinctiveness. It is impossible to compare one traditional technosystem dimensionally or nomothetically with any other. The man-to-man, man-machine and man-nature relationships, which give meaning to a culture's traditional technology, are not measurable in terms of a cumulative quantitative concept of technological progress. A technosystem must be judged in terms of its *meaning, not its contents*. It is in this sense that the use of the concept of

[19]Clande Alveres, *Homo Faber* (New Delhi: Allied Publishers), in press, ch. 1.

[20]It is often a source of great amusement to many modern doctors in India that chemotherapeutic and antibiotic drugs are often used by the medical practitioners of traditional medicine, *Ayurveda*, as a part of ornate *Ayurvedic* rituals, involving controls which have nothing to do with the rituals of drug-prescribing and drug-taking as we know them in modern medicine. However, this is one of the ways in which *Ayurveda* has tried to remain contemporary and provide services to inaccessible social groups which they otherwise could not or would not get.

traditional technology implies a rejection of the theory of progress and of its more recent and somewhat trivial by–product, the theory of modernization.

The theory of progress forces us to look at technology as a cumulative, growing system and culture as a laggard trying to adapt to technological changes *à la* William Ogburn. Take away the idea of progress, and what looks like an advancing technology dragging an unwilling culture behind it may turn out to be a runaway technology unable to adapt to and overstepping the shared values and life–styles of a people. The growth and modernization of technology in this respect is a state of mind, a consciousness produced by a specific cultural concept of technology.

If all traditional technologies are seen as autonomous, culturally valid, competing models of universality, can one compare different traditions of technology at all or analyse their relative merits or demerits? Or are they like different religions, amenable more to comparative analysis than to comparative evaluation? The answer is difficult to give. Absolute relativism would force us to give up all social and cultural criticism, and make the search for a new techno–ethic even more difficult (because every existing techno–ethic would become definitionally legitimate by virtue of being only an extension of its surrounding cultural ethic). On the other hand, we have seen the dangers of a dimensional world–view which sees one particular set of techniques as universal and the rest as parochial, trying to approximate the universality and modernity of the first set but more often than not failing in this effort. I like to believe that the principle of cultural embeddedness merely prescribes that all comparisons among technosystems be, as some psychologists would say, morphogenic or ideographic.[21]

It follows that no traditional technosystem can be historically superior to another. The view is unashamedly *synchronic*. Each traditional technosystem sparkles in the sun as an open but integrated product of a total life–style, flawed by the conflicts and dialectics of that life–style, yet neither comprehensible nor assessable without an understanding of the inputs the technosystem makes to that life–style. The criteria of a good techno–ethic lies in this sense outside technology. That may make technology seem less a pure product of human cognition – which in the first place it never was – and more an expression of the total human personality which it is not often given a chance to become.

[21] Gordon W. Allport, in his well–known writings on the ideographic versus nomothetic approaches in science (see for instance 'The General and the Unique in Psychological Science', *Journal of Personality 30*, 1962, pp. 405–422), seems to suggest that, while the ideographic approach is apt in the human sciences, the nomothetic approach suits the natural sciences better. I doubt whether this position would be considered tenable today. Certainly, in marginal cases like the social studies of technology in the context of man–nature systems, an ideographic approach seems ontologically as well as normatively more appropriate.

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SCIENCE, TECHNOLOGY, AUTONOMY, AND DEPENDENCE: A FRAMEWORK FOR INTERNATIONAL DEBATE*

Ward MOREHOUSE†

In the past 30 years, the role of science and technology in the international system has changed markedly. Science and technology have emerged as primary instruments of power and social control, with the major industrialized countries, especially the superpowers, relying more and more on science and technology as a means of maintaining their dominance in that system. Notwithstanding beachheads of technological competence and scientific excellence in the Third World, the technological gap between the North and the South has widened during this period because of the near-monopoly that a few industrialized countries have acquired on the generation and productive use of new technology based on modern science. Development strategies, relying on importation of capital-intensive, socially inappropriate, environmentally destructive Western technologies, cannot but lead to a massive global equity crisis in the 1980s. These technologies have been at the heart of the accelerating de-industrialization of the Third World by the First and Second Worlds on a scale far beyond what occurred in historical colonialism. The critical need is to focus the debate, at the forthcoming world conferences dealing with science, technology and development, on these underlying issues, leading to the formulation of concrete action proposals at the national and international levels which will effectively promote the technological autonomy of the Third World. While we cannot be certain that greater autonomy will lead to greater equity, few Southern countries can go very far in meeting the minimum material needs of most, not to speak all, of their people without a greatly strengthened autonomous capacity for creating, acquiring, adapting and using technology to solve their own urgent economic and social problems.

*A first draft of parts of this paper was prepared while I was serving as a consultant to UNCTAD's Transfer of Technology Division. Other parts are based on a background paper prepared for the Lund Seminar on Science and Technology in the Changing International System, held at the Research Policy Program, University of Lund, Sweden, in May–June, 1978. I am indebted for ideas and criticism to my colleagues at UNCTAD and Lund, especially Charles Edquist, the Lund Seminar participants, particularly Dieter Ernst, Johan Galtung, and Volker Rittberger, and Claude Alvares of the Rural Study and Transformation Centre (RUSTIC) in Goa. Needless to say, none of these individuals or institutions has any responsibility for the ideas presented here.

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The changing international role of science and technology and the global equity crisis

In the past 30 years, four major trends in the role played by science and technology in the international economic and political system have emerged with increasing clarity:

(1) the accelerating perversion of science and technology into instruments of power and social control;[1]

(2) the relative decline in the overt forms of military and economic power of major industrial nations, especially the superpowers, leading them to turn more and more to technology as a means of maintaining their dominance in the international system;

(3) the widening gap between the North and the South in the capacity for technological advance across almost the full range of economic, social and military activities in which technological change plays a significant role, resulting in increasing technological dependence of the South on the North;

(4) notwithstanding this widening gap and growing dependence, the establishment of beachheads of technological competence in a small but growing number of Third World countries in a variety of sectors of productive activity and social service, including high technology fields such as electronics, space and computers.

A perspective on the 1980s and 1990s suggests that these trends will interact with another pervasive global phenomenon which is already strikingly apparent but which will reach truly alarming proportions by the middle of the next decade. The dimensions of the global equity crisis which is now rapidly engulfing us can be sketched most vividly by using specific national illustrations. In India, which probably has a quarter or more of the billion poorest people in the world, 40% of the population are estimated to live below the poverty line, drawn at the minimum calorie intake just sufficient to stay alive.[2]

Extreme material deprivation is only one aspect of the equity crisis in

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[1] This thesis is elaborated in 'The Perversion of Science and Technology: An Indictment,' a statement adopted by the World Order Models Project in Poona, India, July, 1978, reproduced in the Appendix in this issue.

[2] V. M. Dandekar and N. Rath, *Poverty in India* (Poona: Indian School of Political Economy, 1971). For an extended discussion of the methodological problems involved in determining income distribution in India, see Pranab K. Bardhan, 'The Pattern of Income Distribution in India: A Review', *Sankhya: The Indian Journal of Statistics 36*, Series C, Parts 2 and 4, 1974, pp. 103–138. Estimates of poverty in India vary. Bardhan, for example, estimates that in 1968–1969, 54% of the rural population was below his definition of the poverty line of Rs. 15 per capita per month at 1960–1961 prices (about $3 at the then prevailing exchange rate). This passage is adapted from Ward Morehouse, *Science, Technology and the Global Equity Crisis: New Directions for United States Policy*, Occasional Paper 16 (Muscatine, Iowa: Stanley Foundation, May 1978).

India and other poor countries. Another facet of that crisis is unemployment, underemployment, and employment at very marginal rates of productivity. These have already reached shockingly high levels. Between 1961 and 1971, the number of landless and almost landless agricultural labourers in India, for whom these conditions are especially acute, grew by 90%. But what lies just ahead is even worse. Between 1974 and 1984, India's male labour force alone will increase from 152 million to 196 million.[3]

Development strategies radically different from the 'trickle–down' efforts of the past 30 years will be necessary to generate employment on the massive scale needed in Third World countries like India. 'Trickle–down' development policies have been based on the rapid and indiscriminate import of capital–intensive technology from industrialized countries. While these policies have unquestionably generated economic growth, they have, if anything, aggravated, rather than alleviated, the equity crisis in many, perhaps most, Third World countries.

The principal result of these policies has been the creation of small urbanized pockets of relatively high incomes in a sea of human deprivation and misery. Very few Third World countries have been able to escape this polarization between urban élite prosperity and rural poverty. In fact, evidence shows that rapid economic growth results in even greater income inequality.

Brazil is an outstanding example of a country increasing its GNP at 5–6% a year through aggressive acquisition of capital–intensive advanced Western technology in order to increase export earnings and then import more of such technology. Between 1960 and 1970, a decade of high economic growth in Brazil, the share of the national income received by the top 5% of the population increased from 27% to 35% according to official Brazilian figures. (Private estimates suggest that the top 5% were receiving as much as 46% of the national income by 1970.)[4]

This kind of skewed development effort, based on imported technology, has not only exacerbated the equity crisis in the Third World, but has had two other adverse consequences. Instead of increasing the autonomous

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[3]K. N. Raj, 'The Economic Situation', *Economic and Political Weekly* (Bombay), July 3, 1976, p. 995. The relationship of technology to poverty and socio–economic equity is further discussed in Ward Morehouse and John Sigurdson, 'Science, Technology and Poverty: The Issues Underlying the 1979 United Nations Conference on Science and Technology for Development', *Bulletin of Atomic Scientists*, December 1977.

[4]James H. Weaver, Kenneth P. Jameson, and Richard N. Blue, 'A Critical Analysis of Approaches to Growth and Equity'. Paper prepared for International Studies Association Annual Meeting, March 17–20, 1977, St. Louis. See also Hollis Chenery *et al.*, *Redistribution with Growth* (Oxford: Oxford University Press, 1974), and Irama Adelman and Cynthia T. Morris, *Economic Growth and Social Equity in Developing Countries* (Stanford: Stanford University Press, 1973).

capacity for local problem-solving in respect of critical economic and social needs, it has stifled the development of this capability in many developing countries, because of the ready availability of apparently 'superior' outside solutions to local problems. The result is not decreasing but increasing dependence on outside sources for new technologies to fulfil unmet economic and social needs. In many ways, the energy-intensive agricultural technology known as 'green revolution', with its technologically sophisticated inputs, is the classic example. And as Third World countries are drawn further and further into the web of growing technological dependence on the First and Second Worlds, their autonomy becomes further eroded.

Technology as an instrument of manipulation and de-industrialization

Technological dependence is only one facet of the large and varied set of asymetrical economic and political relationships between the North and the South. These relationships have been extensively analysed by students of international relations, particularly those who see such dominance-dependence as one of the principal, if not *the* principal, characteristics of the contemporary international system.[5] The critical issues in the present context are whether dominance-dependence is increasing in the international system and whether the near-monopoly of the capacity for innovation in scientifically sophisticated technology in the North is a major factor in this increase.

There is ample evidence to support the first proposition. One of the major compulsions for turning to technology as a manipulative instrument in international relationships is, as we have suggested, the relative decline in the efficacy of other forms of military and economic dominance of the major industrialized countries, especially the superpowers. (The polite phrase in superpower policy documents for technology as an instrument of international manipulation is 'policy leverage'.[6]) The phenomenon is found in both East-West and North-South relations. Two recent examples will suffice –

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[5]The literature on dominance-dependence in the contemporary international system and its structural characteristics and historical roots, is substantial and the basic thesis widely recognized, even if not universally accepted. See, e.g., Rajni Kothari, *Footsteps into the Future* (Delhi: Orient Longman, 1974), and various works of Johan Galtung, Helge Hveem and others associated then or now with the Peace Research Institute, Oslo.

[6]See, for example, Ad Hoc Planning Group for the National Conference on Science, Technology and Development, Interagency Working Group on Technology, *Final Report on Alternative Arrangements for the National Conference on Science, Technology and Development*, Report to Undersecretaries' Committee on North/South Policy (Washington, D.C.: US. Department of State, 6 January 1977).

the use of advanced oil drilling technology by the US as a bargaining chip in US–Soviet relations, and India's difficulties in supplying one of her nuclear power stations (itself an aberration in India's generally autonomous atomic energy programme) with imported fuel from the United States.

Indeed, the Indian illustration suggests another caution. A strategy which seeks to strengthen national political and economic autonomy through aggressive acquisition of high technology may, paradoxically, lead, not to greater technological autonomy, but to greater dependence at a qualitatively higher level. The irony of the Indian situation is that the principal architect of India's atomic energy programme, the late Homi J. Bhabha, was acutely aware of these hazards and, while trying to develop nuclear technology in India, he gave high priority to preserving its autonomous character.[7] India's experience in this field underscores the difficulties in breaking the bonds of technological dependency, particularly when a handful of nations effectively control most of the capacity to generate new technology in that field.

The other proposition, that dominance–dependence is rapidly growing in the international system, challenges conventional wisdom by asserting that the efforts of Third World countries over the past 30 years to strengthen their autonomy through 'development' have, in fact, only increased their dependence on the industrialized countries of the North. This thesis argues that the 'de–industrialization' during the era of historical colonialism pales to the point of insignificance when compared with what is happening now. 'In the name of "development" (once it was in the name of "civilizing" the natives),' Claude Alvares, the Indian social activist and observer of the role of technology in social change, has written in a trenchant statement of this thesis, 'more de–industrialisation is taking place today than ever contemplated before. The real distintegration of non–Western societies and cultures is only now being witnessed, that too on a gigantic scale. Everywhere, indigenous peoples are being displaced from their traditional, independent means of livelihood in industry and agriculture, and being thrown to the winds.'[8]

Alvares identifies three principal mechanisms or imperatives of the present–day de–industrialization of the Third World. The first is 'the obscene and gargantuan appetite of the Western industrial machine', leading to the relentless search for more industrial raw materials wherever they can be

[7] H. J. Bhabha, 'Science and the Problems of Development,' *Science 151*, 1966, pp. 541–548. See also Dieter Ernst, *Technological Dependence and Development Strategies* (Hamburg: Projekt Technologietransfer, February 1978, xerox).

[8] Claude Alvares, 'Development against People', *Development Forum*, July 1978, n. 9. Subsequent quotations in this section are taken from the same source and page. Some of these points are further developed in Alvares, *Homo Faber: Technology and Culture in China, India, and the West, 1500 to the Present Day* (Delhi: Allied, and The Hauge: Martinus Nijhoff), forthcoming.

found and the wholesale displacement of poor people and despoliation of the land which accompanies the extraction of these materials.

The second mechanism is generated by the enormous consumption of non-essential goods by mass markets in the industrialized countries. The situation, in fact, has been exacerbated over the last 30 years by the increasing affluence of large numbers of people in these countries. This means, in Alvares's words, 'that as more people want flowers on their breakfast tables, more agricultural land in Southern nations must be recruited to the monumental task.' He goes on to argue that

> If you study the situation carefully, you will see that more and more good land is being placed at the service of the MNCs in Southern nations for crops like vegetables, strawberries, mushrooms, and flowers. Poor people do not sell their lands to the MNCs; in most cases they are just driven off, and in other cases, rich landowners sell off the best land in their possession to the companies at a premium.

The third mechanism is embedded in the Northern capacity to control the direction of technological change for productive activity in the South. This mechanism operates, according to Alvares, even when Southern scientists and technologists, and the institutions they inhabit, become important actors in the dissemination of the technology thus generated (and, in fact, play a role in its generation, but always with the critical elements of direction maintained in Northern hands through development agencies, banks, foundations, and scientific institutions). Citing Evan Vallianators,[9] Alvares argues that

> . . . the green revolution has not only become counter-productive but counter-poor. Everywhere the small farmer (the mainstay of traditional agriculture in the South) is being pushed out or bought out of his small plot of land, as the green revolution jacks up land values and profits.
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> The green revolution, from conception to implementation, is a completely Western technological invention; not only is its funding American, inputs from its successful operation come from agribusiness multinationals . . . Any further extension of the green revolution is going to lead to a disruption of traditional agriculture on a magnitude beyond the imagination of historical colonialism. Already, it is statistically easy to prove that the number of landless peasants has increased since the expensive technology was introduced.

These mechanisms for de-industrialization of the Third World, with all their socially deleterious consequences for the Southern poor, have come into full play only *since* these countries became nominally independent politcally in the last 30 years. Set alongside the accelerating global equity crisis which will be upon us with full force by the mid-1980s, these two phenomena – de-industrialization and the equity crisis – provide a melancholy backdrop for the forthcoming international debate on the human prospect during the remaining decades of this century and millennium.

[9] Evan Vallianatos, *Fear in the Countryside: The Control of Agricultural Resources by Non-Peasant Elites* (Cambridge: Ballinger, 1976).

Setting the stage for international debate

One thing is clear: we shall not lack opportunities for debates on these issues and on what should be done about them. The engagements book of the international community for the next couple of years is crowded with global conferences where these issues could be seriously debated if there was any disposition to do so. In 1979–1980, diplomats, politicians, scientists, and 'development' experts will assemble in large numbers at vast expense on such occasions as UNCTAD V, the UN Conference on Science and Technology for Development, UNIDO III, meetings of the Brandt Commission (the Independent Commission on International Development Issues, to give it its formal title), and the UN General Assembly Special Session on the Third Development Decade, not to mention literally dozens of preparatory meetings, regional conferences, interregional seminars etc. on the same general themes or on subsidiary issues. The principal beneficiaries of all these international confabulations are the airlines, the hotel owners – apart from the conference delegates – who are thus enabled to keep their business going, and not the poor and dispossessed for whose welfare this enormous exercise in global mobility is allegedly being mounted.

What are the chances that the underlying issues of human misery and deprivation will be seriously debated, leading to the formulation, if not implementation, of positive programmes to alleviate their distress? They seem slim, because most of those involved in these international fora are themselves part of the problem and, as professional 'problem–solvers', they have a vested interest in maintaining the *status quo*. As Claude Alvares has observed, 'the consistent failure of development efforts does not deter even more charged attempts to continue discredited programmes. This is the explanation why scholars and bureaucrats still get together for international conferences to discuss "science and technology for development" . . .'[10]

Still the slim chance seems worth taking if only because raising the political consciousness of the powerful and, perhaps even more importantly, the consciousness of those whose support the political élites of the North and the South alike require to maintain their power, is one critical element in any strategy of change likely to surmount the phenomena of de–industrialization and the equity crisis. There should be no illusions, however, that political consciousness–raising alone will lead to an alleviation of either. This is an issue to which we shall return in the concluding sections of this paper, but it should in the meantime be recognized for what it is – just one step along the

[10] Alvares, *Development Forum* (f.n. 8). See also Volker Rittberger's 'The New International Order and United Nations Conference Politics: Science and Technology for Development as an Issue Area' (revised draft), August 1978 (xerox), for a discussion of the problem of the 'problem–solvers' in international discussions of science and technology for development.

way, a prelude to the mobilization of new economic and political coalitions and forces. The saving hope of the international debate is that such mobilization may yet effectively challenge the unholy alliance of power, privilege, and technology which has come to dominate contemporary society with such tragic consequences for the dispossessed of the world, especially the hundreds of millions of poor people in the Southern countries.[11]

Areas of consensus in the international debate

There appears to be general agreement among national governments of most, if not all, countries on the following issues:

(1) strengthening the science base in Southern countries;

(2) building up the technological infrastructure in these countries;

(3) developing technology more appropriate to the economic and social needs of developing countries;

(4) transferring, on equitable terms, more readily available technologies already in the public domain from industrialized to developing countries;

(5) encouraging more research in industrialized countries on the specific problems of developing countries;

(6) using science and technology more effectively to help all nations to cope with common long-term global problems.

There is little point in convening large international conferences to discuss issues on which widespread agreement already exists. What UNCSTD and the other forthcoming international events mentioned above can do usefully on these issues is to address themselves to more concrete questions of implementation, especially on the question of how to bring about a greater measure of compliance where targets and goals have already been established (at least in principle if not in universally accepted quantifiable terms). These targets and goals seem, on closer examination in the light of the phenomenon of de-industrialization and the global equity crisis, still worth pursuing. A good example is the so-called Target III of the International Development Strategy[12] – namely, research in industrialized countries on specific problems of developing countries (point 5 above).

More important than quantified targets, however, is the mode of their

[11]The 'unholy alliance' is examined in Ward Morehouse, 'Technological Autonomy and Delinking in the Third World: Confronting the Unholy Alliance of Power, Privilege, and Technology in Rich and Poor Countries' (Paper prepared for international workshop on 'Technological Dependence – A Major Hindrance for Autonomous Development', Bonn, FRG, 2–5 November, 1978).

[12]UN General Assembly Resolution 2626 (XXV), 24 October 1970.

implementation. Indeed, implementation of goals such as Target III in the wrong way will exacerbate the problems of dominance–dependence and maldistribution of scientific and technological activity in the international system. Thus, the essential conditions for implementation of Target III include the establishment of international procedures for monitoring individual industrialized country's compliance and for determining problem selection (in which Third World countries should have the dominant voice, since they are in the best position to know their own problems). Conditions must also include active participation of Third World research workers and institutions in the research areas so identified so that they can benefit from the experience of working on the solution of their own problems. Enough progress has been made in quantification of R&D activities in industrialized countries to fix a target in terms of a predetermined percentage of total R&D expenditures feasible in the 1980s.

Similar efforts could be made with respect to the other issues identified above. Thus, in connection with point 6, ten decade–long international research efforts along the lines of the International Geophysical Year and directed toward generally recognized global problems (e.g. pollution of the upper atmosphere) might be identified in the UNCSTD preparatory process, appropriate mechanisms for implementation designed or designated, and specific pledges of financial support from individual countries sought prior to the actual convening of the conference.

Here, again, the mode of implementation is crucial. The international debate should include a critical examination of past performance of global research projects and a consideration of alternative institutional arrangements for their implementation. Minimally, Third World scientists and research institutions should be much more actively involved from the very beginning in the choice of research areas and project designs and not be relegated, as in the past, to the role of collectors of data for analysis in the laboratories of industrialized countries.[13]

The importance of concrete action in areas of existing consensus is as much tactical as substantive, for it will demonstrate that international agreement and cooperation are possible. This should help improve the political visibility and utility of conferences like UNCSTD, making it possible to address simultaneously issues about which there is real conflict. But concrete action in areas of consensus must not be allowed to become a smoke–screen to prevent serious attention being given to issues of genuine conflict, some of which will be discussed in the paragraphs below.

[13] See 'Guidelines for International Scientific Cooperation.' (Interim Draft). *Pugwash Newsletter*, May 1978.

Some issues for international debate

The declaration of principles emerging from the various conferences should include issues on which there is genuine disagreement. Instead of papering these over with bland language of the lowest common denominator of agreement, or pushing through a text by the majority from which opposing points of view have been excluded (thereby obscuring the underlying fundamental conflicts), declarations should be sought which, while emphasizing meaningful agreement where it has been achieved, also stress areas of continuing disagreement.

Vital to the task of formulating conference declarations, which address themselves not only to areas of bland consensus but also to underlying issues in conflict, is the choice of subjects for debate. Topics must not be avoided because they are contentious. Rather, the criteria of selection should be whether or not they are significantly related to serious social, economic and political problems and whether their debate in an international forum would contribute to raising consciousness about the most (or least) promising ways of working toward a solution of these problems.

(1) *Technology as the new instrument of global domination.* As the overt military and economic power of the major industrialized countries, especially that of the superpowers, declines relatively, technology will emerge as a major new instrument for maintaining the existing dominance–dependence relations in the international economic and political system. Such a trend is already visible. In political terms, this is what conferences on science and technology for development are all about – or at least should be.

(2) *The role of technology in the accelerating de–industrialization of the South by the North.* Debate on this issue should start by recognizing that what occurred during the era of historical colonialism is a pale shadow of what is now going on. The principal mechanisms and imperatives for this accelerating process of de–industrialization, discussed above, should be scrutinized in order to identify appropriate counter–measures.

(3) *Technological autonomy, not capacity, as the goal of developing countries.* If the preceding propositions are valid, then the goal of developing countries should not be to strengthen their technological capacity when that capacity is essentially derived from industrialized countries. Instead, it should be to increase their autonomous capacity for directing technological change toward tackling their own economic and social problems. Growing evidence suggests that increasing technological capacity along derivative

lines results in continuing dependence at qualitatively higher levels.[14] Technological autonomy is not, of course, autarky, but it does imply greater selectivity in, and closer control of, externally acquired technology.[15]

(4) *Selective technological delinking as a strategy for achieving greater autonomy.* If technological autonomy, not mere capacity, is the goal for developing countries, and if, as a number of analyses suggest, autonomy cannot be achieved in the face of increasing technology flows from developed countries, then a strategy of *selective* delinking may be the only viable means of realizing significantly greater autonomy.[16]

Selective delinking does not, of course, mean technological isolation of the Third World. Obviously, isolation would be foolish in view of the overwhelming preponderance of the industrialized countries in virtually all areas of modern technology. But it does imply slowing down the quantity of North–South technology flows and, at the same time, strengthening the autonomy-generating qualitative character of these flows. It means carefully chosen technology acquisitions *on the initiative of Third World countries*, rather than, as at present, an indiscriminate North–South technology movement – allegedly determined by the 'market mechanism' (highly imperfect in international technology transactions) but, in fact, heavily influenced by the governments and corporations of industrialized countries through tax, trade, and development policies and marketing techniques designed to influence product choice.

This will require far greater efforts at meaningful scientific and technological cooperation among Third World countries. Such a cooperation may not have been possible in the past, but by the 1980s enough beachheads of

[14]Galal A. Amin, 'Dependent Development', *Alternatives II*, 4, 1976, pp. 379–403, and Dieter Ernst (f.n. 7). See also Ashok Parthasarathi, 'Self-reliance as Alternative Strategy for Development', *Alternatives II*, 3, 1976, pp. 365–377, a report on the Pugwash Symposium on Self-reliance, held in Dar es-Salaam, June 1975; and W. K. Chagula, B. T. Feld, A. Parthasarathi, and P. J. Lavakare (Eds.), *Pugwash on Self-Reliance* (Delhi: Pugwash Conferences on Science and World Affairs, 1977), a monograph based on this symposium.

[15]J. Barzellato, 'Self-reliance and International Collaboration in Science and Technology', in *Pugwash on Self-Reliance* (f.n. 14), pp. 174–181.

[16]See, for example, Francisco R. Sagasti, 'Underdevelopment, Science and Technology: The Point of View of the Undeveloped Countries – A Discussion Paper', *Science Studies 3*, 1973, pp. 47–59. For the dependency-inducing and perpetuating and economically and socially distorting consequences of continued technology imports by developing countries, see P. Mohanan Pillai and K. K. Subrahmanian, 'Rhetoric and Reality of Technology Transfer', *Social Scientist*, 54–55, January–February 1977, pp. 73–92; and Frances Stewart, *Technology and Underdevelopment* (London: Macmillan, 1977). These issues are also discussed in Ward Morehouse and Jon Sigurdson, 'Science, Technology and Poverty: Issues Underlying the 1979 UN Conference on Science and Technology for Development', *Bulletin of Atomic Scientists*, December 1977, pp. 21–28. The delinking issue is further discussed in Morehouse, 'Technological Autonomy and Delinking in the Third World' (f.n. 11).

technological competence, even in high technology areas such as nuclear energy, space, electronics and computers, will have been established in the Third World to make collective self–reliance a much more viable approach *if* the Southern countries engage in genuine sharing among themselves.[17]

(5) *Technologies for basic human needs and the imperialism of social priorities.* There is an increasing tendency in some industrialized countries to re–orient their development programmes toward a so–called 'basic needs strategy'. The recent endorsement by the OECD Development Assistance Committee of the basic–needs concept as a priority for allocating official development assistance is a good case in point.[18] (What is really meant in such contexts is minimum material needs, itself a complicated proposition which defies global definition in equitable terms. 'Basic human needs' cannot be defined except by the active participation of those whose needs are involved.)

It is likely that some industrialized countries will come to UNCSTD and other forthcoming international forums with a call for more emphasis on developing technologies appropriate to meeting minimum material needs in developing countries. The internal political imperative within industrialized countries for such an emphasis should be recognized by developing countries. The imperative stems from an effort to disarm critics of more forthright policies on North–South issues who oppose such policies on the ground that past offorts have not benefited the rural poor within Third World countries but have only made the relatively affluent, largely urbanized, elites better off.

At the same time, industrialized countries need to recognize that this preoccupation with minimum material needs within developing countries is, at best, seen by the Third World as a tactic to divert attention from the hard question of restructuring the international economic and political system. If the industrialized countries are so concerned with issues of equity in the Third World, let them also look at inequities in the international system as well. At worst, this preoccupation is perceived by Southern countries as a gratuitous interference in their internal affairs. If there is to be international discussion of social priorities and of the method of achieving them within developing countries, then let the debate at forthcoming international

[17]See Francisco Sagasti's paper in this issue of *Alternatives*. Various proposals for Third World cooperation in science and technology for development are summarized in David Chu, 'Third World Cooperation in Science and Technology for Development' (Background paper prepared for NGO Forum on Science and Technology for Development, New York, September 1978, preliminary conference version).

[18]See the Communique of the Sixteenth Annual Meeting of the OECD Development Assistance Committee, Paris, 27 October 1977. OECD Press Release A (77) 47.

conferences also include a discussion of the steps necessary to develop technologies appropriate to alternative and less consumptive life-styles in industrialized countries.

In all discussions of technologies to meet minimum material needs (sometimes subsumed under the label of 'appropriate technologies'), at least two additional points should be emphasized. The first is that technologies which truly break new ground in meeting these needs require a highly sophisticated science base for their development; they are not primitive or simple-minded, common-sense solutions to technological problems of the poor (although they certainly should embody the properties of common sense). The second is that these technologies must be developed primarily *in* Third World countries; institutions and individuals in industrialized countries, no matter how well intentioned, have, at best, a minor role to play. If these conditions are not satisfied, the developing countries will simply be substituting one kind of technological dependence with another.[19]

(6) *The new development myth of technological change to alleviate poverty in the absence of a social transformation.* For all the forthcoming international discussion of the theme of 'science and technology for development', the world community is in danger of becoming seduced by a new piece of development mythology: that technology alone can solve deep-rooted and pervasive social problems such as widespread poverty and oppression in Third World countries, and indeed also in industrialized countries where these conditions, though perhaps less widespread (poverty – yes; oppression – arguable, depending on the social critic), certainly exist.

Technologies can, of course, help to solve such social problems just as they have helped to create them. But the overwhelming weight of historical evidence supports the proposition that the technological transformation of a society does not occur in the absence of a social transformation. Three major examples in the twentieth century are the Soviet Union, China, and Japan.[20]

[19]See A. K. N. Reddy, K. K. Prasad, and K. S. Jagadish, 'Problems in the Generation and Diffusion of Appropriate Technologies: Part II – ASTRA – An Institutional Experiment', Bangalore: Indian Institute of Science (mimeo), (n.d.–1977); and A. K. N. Reddy, 'National, Sub-regional and Regional Institutions: A Preliminary Assessment', Paper prepared for Expert Meeting on International Action for Appropriate Technology, International Labour Office, Geneva, 5–9 December, 1977. ASTRA is the acronym for the Cell on Application of Science and Technology to Rural Areas, an on-going project at the Indian Institute of Science.

[20]Carlos Contreras, Charles Edquist, Osita C. Eze, Ward Morehouse, B. B. Rangarao, and Mervyn Wijeratne, *Technological Transformation of Developing Countries*, Discussion Paper Series No. 115 (Lund: Research Policy Program, University of Land), February 1978, pp. 4–5. This paper, based on consultations organized by UNCTAD in Geneva in January 1978, has also been published by UNCTAD under the title, *Technological Transformation of the Third World: Issues for Action in the 1980s* (Geneva: United Nations, 1978), UNCTAD/TT/9.

More points for debate

The foregoing propositions for debate hardly exhaust the list of possibilities. Here are ten which I prepared as an input into the first NGO Forum on UNCSTD. They are cast in deliberately extreme form as formal resolutions in an effort to stimulate active discussion of the pros and cons and an active search for alternative ideas and approaches. They encompass some of the issues for debate outlined above, typically in more concrete form, and introduce a number of additional issues which are also important in raising consciousness about the changing role of science and technology in the international system.

(1) Resolved that, in order to break the vicious circle of dependency (lack of autonomy), there be a ten-year moratorium on new transfers of technology from industrialized to developing countries during the Third Development Decade.

(2) Resolved that there be a ban on the export of unprocessed raw materials from developing to industrialized countries.

(3) Resolved that all constraints on technology transfer be removed, including patents and other restrictions on proprietary technology.

(4) Resolved that national science councils or equivalent bodies in developing countries be abolished.

(5) Resolved that all countries now spending more than one-third of their national R&D budget on military technology reduce that proportion at the annual rate of 5% until it is less than one-third.

(6) Resolved that science and technology for basic human needs is a plot by the industrialized countries to maintain the Third World in a perpetual state of dependence to the First and Second Worlds.

(7) Resolved that technological optimists who argue that the social and environmental pathologies generated by modern technology in the industrialized countries can be overcome by more such technology are players in the theatre of the absurd.

(8) Resolved that the central issue before UNCSTD and other international forums on science and technology for development is to halt the perversion of science and technology as instruments of power and social control and to reassert their nature as instruments for the pursuit of truth and human liberation.

(9) Resolved that international conferences on science and technology for development are smoke-screens through which political, scientific and other élites in the North and the South alike seek to divert attention from urgent social and economic needs in order to maintain their positions of power and privilege.

(10) Resolved that unless the intellectual bankruptcy of world

conferences can be arrested and reversed, such conferences serve no socially redeeming purpose and should be boycotted.[21]

Some ideas for action

Unless the debate on propositions such as the foregoing is to remain purely academic, it should lead to the formulation and implementation of concrete ideas for action. Here are several; additional ideas, sometimes variants of what follows, have been put forward by other contributors to this special issue of *Alternatives*, especially Francisco Sagasti.

It should be emphasized at the outset, however, that in the absence of an accompanying social transformation within the countries involved in implementing them, these ideas will be, at best, palliatives and, at worst, will exacerbate the global equity crisis now enveloping us. Most of them should therefore be seen as interim or transitional strategies to mitigate the worst excesses of the existing state of technological dependence of the Third World on the First and Second Worlds.

The central thrust of these ideas is toward strengthening the autonomous capacity of Southern countries to choose, create, acquire, adapt, and use technology to solve their most urgent economic and social problems. It should also be emphasized that greater technological autonomy will not necessarily lead to greater social equity. On the other hand, there is evidence to suggest that few Third World countries have gone very far in meeting the minimum material needs of most of their peoples on a sustained basis without a substantially increased autonomous capacity for technological change.[22]

A. Action at the national level in Third World countries

(1) *Strengthening national agencies for technological development.* If developing countries are to enhance significantly their autonomous capacity for directing technological change toward a solution of their most urgent

[21]Ward Morehouse, 'Ten Propositions for Debate (at the 1979 UN Conference on Science and Technology for Development, NGO Forum on UNCSTD, and Other Conferences on Science, Technology and Development), New York: Council on International and Public Affairs, 20 September 1978 (xerox). Several of these were first put forward in Morehouse and Sigurdson, *Bulletin of Atomic Scientists* (f.n. 16).

[22]The autonomy/equity issue is explored at greater length in Morehouse, 'Technological Autonomy and Delinking in the Third World' (f.n. 11).

economic and social problems, they must increase their capacity for generation of indigenous technology and for more effective control of foreign technology. Some developing countries have already created such agencies; in these cases, their performance should be critically assessed to see how they can be made better instruments for promoting the country's technological autonomy and social equity. Others have yet to establish such agencies or are now in the process of doing so; they should be encouraged to move forward with all possible speed, special attention being given to serving the needs of the poor.

Because of the enormous variety within Southern countries, no single blue-print for a national agency for technological development is possible. In some cases, a new entity will have to be created; in others, an existing institution may take on added functions. In still others, a series of sectoral agencies dealing with agriculture, different fields of industry, transportation, etc. may be the most appropriate arrangement. But whatever the specific institutional arrangements, the essential functions to be served would include:

(a) identifying technological requirements in all economic and social sectors;

(b) assisting in the acquisition and analysis of information on alternative sources of technology;

(c) participating in the evaluation and selection of technologies needed for specific social and economic programmes or objectives;

(d) serving as an instrument for developing indigenous technology through support of local research efforts, implementation of incentive schemes for indigenous technologists, design and support of performance guarantees for indigenous technology to make it more competitive with foreign technology;

(e) acting as a registry for foreign technology and participating in negotiations over its acquisition in a form which will enhance rather than inhibit the development of indigenous technological capacity;

(f) Preparing periodically updated short- and long-range technology plans for the country as an integral part of its overall economic and social plans and reviewing and formulating the country's technology policies on a continuing basis.[23]

Because some developing countries have had considerable experience in trying to create mechanisms to perform these functions, an early step in

[23] United Nations Conference on Trade and Development, *Transfer and Development of Technology in Sri Lanka: Report by an UNCTAD Mission*, Note by the UNCTAD Secretariat (Geneva: United Nations, 1976), UNCTAD/T/T/5, pp. 17–49.

implementing this action proposal should be a critical assessment of their successes and failures so that mistakes may not be repeated. The caveat about technological change in the absence of social transformation applies with particular force here, as there is some evidence to suggest that these kinds of policy mechanisms may increase the flow of socially inappropriate technology for the needs of the modern urban sector by reducing the cost of external acquisition.[24]

(2) *Designing and creating alternative technology systems.* A number of studies in recent years have underscored the marginal relationship of most formal science and technology systems created in the Southern countries in the past 30 years with their countries' most urgent economic and social problems.[25] This is not surprising, because these systems have been generally modelled after systems which have emerged in industrialized countries with entirely different needs and patterns of production.

Two critical tasks confront Third World countries. First, where such formal systems exist, a conscious and determined effort needs to be made to re-orient these systems toward concentration on local economic and social problems, especially the unmet needs of the poor, and to fashion closer links with the productive sectors of the economy from which they are typically relatively isolated. Second, where such systems do not exist, alternative systems for technological development better suited to the needs of the majority of the population in these countries need to be created, whether at the local, provincial, or national level. Again, blue-prints are difficult because of the enormous diversity within Southern countries, but some models do exist. Some of the essential characteristics of alternative technology systems can be identified, including:

(a) closer links with, if not as an integral part of, the productive system;

[24]The cooperative Science and Technology Policy Instruments (STPI) Project, involving a cross-section of developing countries from all major regions of the Third World, has been engaged in such a critical assessment. A summary report by the project coordinator, Francisco Sagasti, is now in press. Some country-level studies in the STPI Project have been published already – e.g. Alejandro Nadal's analysis of Mexican science and technology policy instruments, which has appeared in Spanish in Mexico (published by the El Colegio de Mexico, Maxico City) and is expected to be published subsequently in English by the Canadian International Development Research Centre, Ottawa. See also Lynn K. Mytelka, 'Regulating Foreign Investment and Technology Transfer in the Andean Group', *Journal of Peace Research 14*, 2, 1977, pp. 165–182, and her draft paper 'Technology Dependence in the Andean Group'.

[25]On the marginalization of formal science and technology system in developing countries, see the various writings of Amilcar Herrera, Francisco Sagasti, A. K. N. Reddy, and Charles Cooper, among others. A schematic representation of this phenomenon is given in Morehouse and Sigurdson (f.n. 16). See also Ashis Nandy in this issue (pp. 371–385).

(b) priority to developing technologies to fulfil the unmet needs of the poor;

(c) active participation of users in problem identification and the testing of solutions;

(d) more emphasis on mechanisms for rapid diffusion of tested innovations;

(e) creation of feedback mechanisms so that user refinements and improvements can quickly be incorporated in redesigned innovations and widely disseminated;

(f) attention to small, incremental improvements in existing technologies as well as to 'breakthrough innovations';

(g) a strong scientific base where new solutions to fundamental problems are being sought.[26]

Several projects, particularly within the United Nations University Human and Social Development Programme, are now under way to spell out in greater detail how such alternative technology systems should be designed and to look more closely at existing models.[27] Because much of this work is in progress and not yet available in published form, a small group of persons working in this area might be usefully assembled to spell out more concrete proposals for the various forthcoming international conferences.

B. *Action at the national level in industrialized countries*

Although most of the action required to strengthen the technological autonomy of Third World countries must take place within those countries or at the international level, there are some specific steps which industrialized countries should take. These are listed here only briefly because I have spelled them out in a more extended form recently elsewhere.[28]

Before turning to the possibilities enumerated below, one general proposition should be stressed as a starting point for industrialized countries' response to Third World efforts to strengthen their autonomous capacity for technological change. The single most important step which the First and

[26]See A. K. N. Reddy, K. K. Prasad, and K. S. Jagadish (f.n. 19); Ward Morehouse, 'The Commune as a "Technological System": Notes on Hua-Tung Commune', *China Quarterly*, 67, September 1976, pp. 582–596; and Johan Galtung, *Development, Environment and Technology: Towards a Technology for Self-Reliance* (Geneva: UNCTAD), Draft manuscript in press.

[27]These and other related activities of the UN University are described in United Nations University, *Application of Science and Technology to Development*, Paper submitted to the UN Advisory Committee on the Application of Science and Technology to Development, Tokyo, October 1977.

[28]Morehouse, *Science, Technology and the Global Equity Crisis* (f.n. 2).

Second Worlds can take in this context is to make and honour a pledge of non–interference in the affairs of Southern countries which choose to disengage themselves from the international system and go it alone, in greater or lesser measure and for whatever periods of time. This would be a platitudinous and superfluous advice, were it not for the melancholy record, over the past 30 years, of the larger industrialized countries doing just the opposite in such circumstances. The other steps are:

(1) reassessing existing policies and, where necessary, evolving and implementing new policies to promote full domestic employment, provide adequate assistance to workers and communities affected by changing international economic conditions, and develop alternative technologies to cope with structural unemployment and promote resource and energy conservation. These are the essential political and economic preconditions for more forthcoming policies on the part of industrialized countries related to the Third World;

(2) extending the coverage of existing policies and regulations on restrictive and unethical business practices and environmentally damaging industrial activities, including the overseas operations of MNCs headquartered in the developed countries and their foreign subsidiaries. This would not rule out effective multilateral arrangements to serve the same goals;

(3) initiating internationally negotiated and time–bound research projects on specific problems of developing countries at quantified levels, jointly selected by Third World and industrialized countries, the research being conducted with the *active* participation of the research workers and research institutions of the developing country concerned (the so–called Target III of the International Development Strategy discussed above).

C. *Action at the international level*

(1) *Establishment of an international association for Third World technological development.* The most important aspect of this organization is not the size of its resources but its purpose and control. Its purpose would be to further the technological autonomy of developing countries, and it should be controlled by those countries.

Contributions to the association should be sought, in the first instance, from the developing countries themselves, with the expectation that the most advanced or resource–rich would provide the most substantial support, although even token contributions from poor developing countries would be useful as a symbolic gesture of commitment to meaningful technological cooperation and would secure seats for such countries on the governing

body of the association. Contributions from industrialized countries and international agencies would be welcome, but only on condition that the allocation and use of these contributions would be determined by the developing countries. If the international seabed authority is ever established, some of its proceeds might be earmarked for the fund.

The association would undertake three types of activities:

(a) acquisition of economically and socially strategic technologies with high multiplier potential from the industrialized countries on as unencumbered terms as possible;

(b) support of joint technology development projects involving more than one Third World country, with emphasis on projects primarily for social benefit to avoid generating economic conflicts among potentially competitive Third World countries;

(c) assistance to regional and subregional technology development agencies within the Third World and to national technology agencies in the smallest and poorest developing countries.

Because of the size and diversity of the Third World, The possibility of separate regional and subregional entities or affiliates for South and Southeast Asia, West Asia, Africa, and Latin America should also be considered.[29]

(2) *Using and annually increasing percentage of UN-administered development assistance for technological cooperation among developing countries.* In order to ensure concrete fulfilment of the often times expressed goal of furthering technological cooperation among developing countries – now given additional endorsement by the September 1978 UN Conference on Technical Cooperation among Developing Countries (TCDC) in Buenos Aires – development assistance programmes administered through the UN and its affiliated bodies and specialized agencies (including the United Nations Development Programme and the World Bank) should increase at the rate of 5% a year until the target of 50% is reached. Good use could be made of experts, agencies, and suppliers from Third World countries in the implementation of development projects with a significant technological component. These experts, agencies, and suppliers should come primarily from the country directly concerned and secondarily from other Third World countries. If this procedure is initiated

[29] Some ideas for such an association have been outlined in Francisco R. Sagasti, 'Notes on Technological Self-Reliance and Cooperation among Third World Countries', in *Pugwash on Self-Reliance* (f.n. 14), pp. 182–196, as well as his contribution to this issue of *Alternatives*. This and the remaining ideas for international action set forth here are elaborated in Contreras *et al., Technological Transformation* (*f.n.* 20).

in 1980 with the beginning of the Third Development Decade, the 50% target will have been achieved by the end of that decade.

(3) *Providing greater UNDP support for projects which strengthen indigenous technological capabilities in developing countries.* There are three major priorities for UNDP's work in this context:

(a) assistance for projects that strengthen indigenous capacity to make decisions about the most effective ways of acquiring technology, designing new or improved technology and linking local scientific and technological communities more closely with the production system;

(b) support for activities that enable the developing countries to get better information about, and access to, foreign technologies most relevant to their needs;

(c) assistance to projects that seek to create new technologies most appropriate to the needs of Third World countries.

These priorities will have implications for national as well as regional programme planning. These were spelled out in a study made half a dozen years ago but, except for marginal response in a few areas, apparently largely ignored by UNDP ever since.[30]

(4) *Re-orienting the World Bank to make it more responsive to the goals of technological autonomy and social equity.* The World Bank under its present leadership has emerged as the principal multilateral source of development financing. It now claims to be promoting growth with equity. While there is no assurance that greater technological autonomy will necessarily lead to greater social equity in Third World countries, few of these countries have been able to increase equity on a significant scale and on a sustained basis without greatly strengthened autonomy. The Bank, therefore, should give more attention to the promotion of technological autonomy within the context of its stated concern with advancing social equity.

To do this, the Bank will need to move increasingly toward support of projects that are organized around indigenous problem–solving skills (even if these result in less than optimally 'efficient' solutions to local problems). Trying to devise projects based on expensive external technical inputs often leads to very costly long–term consequences when measured in terms of social equity and impact on the poor. Indeed, because of the unholy alliance

[30]The study of UNDP by the Sussex Science Policy Research Unit has recently been published as 'Science, Technology and Development: The Role of the UNDP', by C. H.G. Oldham, A. McKnight, R. Turner, and J. Townsend in *Pugwash on Self–Reliance*. See also Muchkund Dubey, 'The Future of the United Nations Development Programme (UNDP)', *Development Dialogue*, 1, 1977, pp. 85–99, for a critical assessment of UNDP.

of power, privilege, and technology both in the North and in the South, and because of the melancholy record of the Bank in promoting growth with genuine equity, scepticism is bound to prevail about the capacity of international development institutions to arrest the process of de-industrialization of the Third World.[31]

Assuming, however, that such institutions can become truly effective supporters of programmes which actually help the poor and dispossessed in the Third World, they will need to develop and use, far more widely than till now, project selection techniques that take into account the all-important 'learning effects' of activities they underwrite. The World Bank and other multilateral financial institutions do control substantial resources and cannot therefore be ignored because of their capacity to do harm to local problem-solving capabilities by overwhelming them with economically more efficient but socially less desirable external solutions. At best, they may be seen as transitional arrangements till Third World countries move toward more autonomous solutions to their own problems. But whether such institutions, which have a vested interest in prolonging their own existence, can become effective mechanisms for furthering autonomous and equitable economic and social change in Third World remains to be seen.[32]

Demystifying the generation of 'political will'

A standard element in the rhetoric about international conferences is the emphasis on the need to generate sufficient 'political will' to lead to action. The lament goes somewhat like this: If national governments could be persuaded to undertake the various actions proposed at such conferences – and insist that international organizations they support and control do so – the multitudinous recommendations spawned by these conferences would be implemented and most, if not all, of the world's problems would be solved.

[31] Perhaps adjusting the voting right in the Bank so as to give the Third World a 50% share would help move the Bank in this direction. For such a proposal, see Amon J. Nsekela, 'The World Bank and the New International Economic Order', *Development Dialogue*, 1, 1977, pp. 75–84.

[32] The Bank has recently attached to the Office of the Science Adviser a consultant on 'appropriate technology' to look at selected Bank projects from the point of view of their social equity and environmental implications. Similarly, an Oxford economist, who has written extensively on technological dependence and underdevelopment in the Third World, has been brought to the Bank for a year's assignment, suggesting that the Bank is internally a variegated rather than monolithic institution. These gestures may, of course, be seen as merely symbolic rather than as reflecting any fundamental redirection of the Bank's role.

This does not happen, of course. And for a simple reason. Implicit in the notion of generating political will to act in solving economic and social problems, whether local or global, is the phenomenon of political voluntarism. But in the real world of relations among nations, as well as in the domestic affairs of nations, perceived self–interest and the power to pursue that interest are the dominant forces which guide political behaviour, although moral and ethical considerations are not wholly absent.

For the United Nations system, another obstacle arises: the taboo on concerning itself directly with the internal affairs of member–states without the explicit approval of the ruling national governments concerned. Thus, UN conferences on themes related to science, technology, and development suffer from a double impediment to their effectiveness in deciding on concrete action. The first is the inability to confront directly the internal problems of social inequity and material deprivation which exist in greater or lesser measure in all countries, except in the generalized rhetoric so typical of world conferences. The second is the lack of meaningful correlation between the character of proposed actions by such conferences and the political power to implement these actions, especially where the actions would adversely affect the existing interest of powerful economic and political groups and institutions within countries.

This point can be readily illustrated by the largely futile efforts of the Third World to acquire technology through diplomatic pressure during the past decade. Experience with international negotiations in the 1970s has demonstrated how difficult it is for Southern countries to acquire *significant* (rather than token or symbolic) access to desired technology on equitable terms when not bargaining from a position of political and economic strength. Preferential terms for developing countries – such as GSP schemes on tariffs or technology transfer – have so far been only crumbs off the tables of rich industrialized countries, not meaningful concessions.

This is not an argument against continuing the effort to make established international political and legal rules less discriminatory in areas such as investment, technology transfer, and patents. On the contrary, such an effort is an essential element in any long–term endeavour to raise political consciousness about the existing discriminatory rules of the game. It is, rather, a plea for a realistic recognition of what can be accomplished. OPEC has demonstrated that only where real bargaining power is present can substantial concessions be achieved; and even the OPEC advantage may prove to be more illusory than real because of the OPEC countries' continuing and growing technological dependence on the industrialized countries.[33]

[33] See Galal Amin (f.n. 14).

The political chemistry for a new science and technology order

Given these circumstances, what are the prospects for challenging the unholy alliance of power, privilege, and technology to arrest the de–industrialization of the Third World, and for confronting meaningfully, if not surmounting, the global equity crisis of the 1980s? In other words, what are the chances of establishing a new science and technology order for which various contributions to this special issue of *Alternatives* argue so vigorously? They are admittedly not great, but neither are they totally bleak. It should, however, be recognized at the outset that the process will be a long one and that there are no easy, quick solutions to such deep–seated, pervasive social pathologies as now afflict us because of the perversion of science and technology into instruments of power and control.

What kind of political chemistry is likely to be involved? Here are some of the key elements;

(1) As we have suggested, it is necessary to raise political consciousness in order to bring about an understanding of the real issues involved in the de–industrialization of the South and in the global equity crisis. Understanding will not necessarily lead to action, but without understanding meaningful action is even more unlikely. This task is the more difficult because it involves challenging widespread misinformation and incorrect conventional wisdom backed by powerful vested interests, about the nature of 'development' and the causes of underdevelopment in the Third World.

A good case in point is the need for slowing down indiscriminate North–to–South technology flows altering the modes of technology acquisition to enhance autonomy and decrease dependence, and targeting acquisitions in selected high priority areas to maximize equity in the process of economic and social change.[34] This formulation flies in the face of conventional wisdom on which international development programmes have been based over the past 30 years, viz. that the way to solve the problems of poverty and oppression in the Southern countries is to increase the flows of technology from the North.

(2) New economic and political coalitions will need to be built up to challenge the vested interests in maintaining the present pattern of technological dependence of the South upon the North. Labour, environmental, consumer and other activist citizen groups in the Northern countries, for

[34]Social equity is here defined as: (1) meeting the minimum material needs of most, if not all, of the population; (2) providing opportunities for productive employment for most, if not all, of the population; and (3) less unequal income distribution, leading to satisfaction of basic social wants (adequate health care, education, etc.) of most, if not all, of the people. See Morehouse, 'Technology Autonomy and Delinking in the Third World' (f.n. 11) p. 44.

example, are concerned about the accountability and regulation of the off-shore activities of multinational corporations; they can be linked with mass political movements of the dispossessed in poor countries in working toward a deceleration of the de-industrialization of the South by MNCs. These groups and movements share a commitment to social justice, which is a moral imperative in the endeavour to halt the de-industrialization of the Third World.

Similarly, like-minded small countries in both the North and the South, which, by virtue of their size, are relatively more dependent and less autonomous actors in the international economic and political system, can evolve common bargaining positions and strategies against the major industrialized countries. They have a shared interest in limiting the dominance of the large actors in the international system in order to enhance their own autonomy.

(3) Next are transitional strategies along the lines of those outlined by me above and by Francisco Sagasti in his paper in this issue of *Alternatives*, coupled with alternative patterns of effort at economic and social change leading to genuine development for all the people of the Third World presented by Ponna Wignaraja and John Forje in their contributions. The extreme distortion in the present global distribution of science and technology resources, with 90–95% concentrated in a handful of industrialized countries and the rest of the world a scientific desert, and the rampant misdirection of much scientific and technological effort to promote socially pathological results (judged in terms of their impact on the poor and dispossessed who constitute the majority of the people in most Third World countries) means that the achievement of the kind of new science and technology order for which Johan Galtung argues in his paper will take time. The contributors to this issue of *Alternatives* may have visionary goals, but they are not politically naive. They understand that to realize these goals will require a long-drawn-out struggle for social justice. These transitional strategies represent concrete, practical first steps in that direction.

(4) Finally, there must be mass political movements in the countries of both the South and the North prepared to join the struggle for social justice, as A. Rahman argues in his paper. The creation of these movements will not be easy or quick. One compelling force may well turn out to be the global equity crisis of the 1980s. Sharply deteriorating economic conditions should accelerate the formation of political consciousness leading to a more rapid political change in the South. In the North, widespread structural unemployment, environmental degradation, and repeated breakdowns of highly centralized energy, communications, transportation and other systems – conditions being aggravated by the present direction of technological change in these countries – will similarly lead to heightened political

consciousness and provide the basis for mass political movements seeking alternative life-styles and patterns of productive activity.[35]

Out of these social and economic trends and circumstances may yet emerge the combination of political forces to challenge effectively the unholy alliance of power, privilege, and technology and to bring about a new science and technology order dedicated to the pursuit of truth and human liberation.

[35]One of the most cogent statements of this thesis is set forth in James Robertson, *The Sane Alternative: Signpost to a Self-Fulfilling Future* (London: The Author, 1978).

Alternatives iv (1978–79) 413–427

APPENDIX: DOCUMENTS

I. THE PERVERSION OF SCIENCE AND TECHNOLOGY: AN INDICTMENT*

This is an indictment of the way in which science and technology have become instruments of a global structure of inequity, exploitation and oppression. So perverted have science and technology become as instruments for power and control that we are confronted with:

— Outrageous schemes, under the guise of 'appropriate technology', to feed the Third World poor on algae and garbage, while their food-producing lands are usurped by transnational corporations and local elites to grow carnations and roses for the world's rich minority;
— Biological farming in the Third World by pharmaceutical transnationals who engage in large-scale drug testing among poor populations and export blood from poor to rich societies;
— The banishment of a growing number of the First World poor from productive activity through increasingly capital-intensive technology manifested by shocking rates of unemployment;
— The employment of 50 per cent of all research scientists in the world in military R&D and a significant proportion of it for developing the technology of mass destruction and repression.

We urge serious reflection and a vigorous debate on our present predicament and an active search for alternative perspectives on science and technology which relate both to the pursuit of truth and to the process of human liberation.

SCIENCE, WESTERN CULTURE AND COLONIAL EXPANSION

Something is seriously wrong. What started as a liberator of the human spirit and held the promise of 'happiness and plenty' for all has resulted in inequity, exploitation, alienation and apathy. Far from being an instrument of human salvation, modern science has gone on a course that threatens survival itself.

To comprehend and cope with the multiple crises of our time, one must first come to grips with the cultural milieu in which modern science grew and the social structure to which it has given rise. It grew in the cultural milieu of the West which put man at the centre of creation and exhorted him to use knowledge to enhance his power. Science, thus, became an instrument of 'mastery' over both nature and the social order and, together with its progeny, modern technology, became the purveyor of imperial expansion, the instrument of ravaging and of

* This statement was signed by twenty-six individuals at the fourteenth meeting of the World Order Models Project in Poona, India, 2-10 July 1978. Those who share these concerns are invited to sign the statement.

manipulation of resources and the environment, of racism, of modern militarism, of fascism and of authoritarian socialism.

While the acquisitive and competitive drive of Western culture had sown the seeds of mercantilism and capitalism in the centuries before the Industrial Revolution, it was only with the availability of the enormous power released by modern science and technology that earlier restraints and the previously surviving sense of community were undermined. From that point on, capitalism acquired an expansionist thrust of new dimensions, undermining the autonomy of various societies, destroying their economies and systems of production, and turning them into vast hinterlands of commodity suppliers for what are today called developed societies. The development of such societies would not have been possible without the deliberate underdevelopment of a great many other societies.

In the course of time this capitalist thrust bent the world to its service. The result was colonialism and, following the success of national liberation movements, neo–colonialism. In fact, the neo–colonial phase, in which the penetration of the transnational corporations makes physical occupation of territory unnecessary, has led to much greater control and ravaging of the Third World, and seduction of its elites into a global structure of power, privilege and wealth. With the Third World political, bureaucratic, military, academic and communications elites accepting the superiority of Western–style 'modernization' and the role of science and technology in it, there has emerged a global system of control, hegemony, exploitation and repression – all in the name of modernity and the theory of progress, all in the name of science and technology.

EXPLOITATION OF THE THIRD WORLD

To cater to the wasteful 'needs' and unnecessary privileges of a rich minority of the world's people, millions of previously independent farmers and artisans are being driven from their land and displaced from their normal livelihood on a scale that makes the ravages of historical colonialism look pale in comparison. To illustrate:

— Traditional fishermen of South Asia are being forced out of their occupations by mechanized trawlers which catch shrimp and other marine delicacies for the well–nourished peoples of the industrial world. The indiscriminate fishing methods of the mechanized trawlers are leading to declining fish stocks and, thus, to a decline in protein consumption among those who have virtually no source of protein other than fish. And this is in spite of the evidence that traditional fishing activities are economically defensible, ecologically sound and employment generating.
— To feed the insatiable demands of the machines of the industrial nations and the equally insatiable desire for foreign exchange among Third World elites hungry for imported luxuries and armaments, large areas are being mined and undermined, forests destroyed, fields flooded, rivers silted, and farmers and tenanats displaced from independent sources of income and livelihood.
— In the name of earning foreign exchange through tourism, where millions of poor need housing, scarce resources are being diverted to construct ten- and fifteen–storey hotels.
— By the same logic, 'surplus' food and meat are being exported while children remain malnourished. Transnational corporations also contribute to infant mortality and disease by actively promoting 'modern' bottle–feeding in place of 'old–fashioned' breast–feeding.
— The compelling drive to sell products made possible by modern technology, regardless of whether they serve any real social need, necessitates colonization of the mind itself. High–powered advertising is used to 'hook' some of the most deprived people of the world on senseless consumer goods, so that a head of family may spend a large fraction of his earnings on Coca Cola while his children starve.

PATHOLOGICAL CONSEQUENCES IN FIRST AND SECOND WORLDS

The social and psychological pathologies visited upon the First and Second Worlds through the perversion of science and technology are no less serious. These pathologies have emerged not in spite of, but because of, modern science and technology. Thus, the 'civilization diseases' – mental illness, heart disease, cancer – are becoming more widely prevalent because of psychological stress and environmental pollution, both of these phenomena being particularly evident in the more highly industrialized societies. Indicators for these 'civilization diseases' and criminality, to give just two examples, are inexorably increasing several percentage points each year in some industrialized countries.

Technologies which require huge capital investments and highly centralized systems of production and distribution and which rely on built-in obsolescence and wasteful consumption of non-renewable natural resources are yet another manifestation of the perversion of modern science and technology. This is reflected in the fact that huge sums are spent for research on socially and ecologically destructive nuclear technology while almost nothing is allocated for the development of renewable resources of energy.

The magnitude of structural unemployment among the poor and exploited in these countries as they are banished from productive activity through increasingly capital-intensive technology is even more alarming. Unemployment rates among young blacks in the U.S. now average 30 per cent and are as high as 70 per cent in some cities. The deployment of industrial robots, which are, needless to say, easier to programme and control than human workers, is already on the horizon and is likely to be operative in a number of industrialized countries by the mid-1980s, unless sharply corrective steps are taken soon.

Nowhere has this perversion of science and technology reached higher levels of obscenity than in the technology of mass destruction and repression. One particularly noteworthy aspect of this situation is that in advanced military technology, R&D activity itself provides the motive force for ever-increasing expenditures on armaments by all countries and growing arms transfers from the major powers to the Third World. When one superpower develops a more destructive weapons system to maintain its presumed advantage over its adversary, the other superpower redoubles its R&D effort to overcome that disadvantage. Other countries then calmour for these weapons to maintain their advantage over their regional adversaries. The result is both increasing appropriation of world resources by the arms race between the superpowers and growing militarization of Third World countries through massive arms exports as well as the export of technologies of repression which are used by local elites to put down movements of social and political change.

ABSURDITY OF TECHNOLOGICAL OPTIMISM

Technological optimists argue that the social pathologies generated by modern 'high' technology can be overcome by more such technology. They would be players in the theatre of the absurd if they did not occupy positions of power and influence in the real world of today. Humanity must regain its sanity by reasserting the nature of scientific inquiry as the pursuit of truth, leading to technologies which liberate the many rather than facilitate control by the few.

ALTERNATIVE MODES FOR SCIENCE AND TECHNOLOGY

The scientific enterprise must henceforth be directed especially towards the needs, skills and knowledge of the majority of the underprivileged peoples of the world, especially those in the

Third World. This means creative interplay between the saner elements in the prevailing paradigm of science and technology and elements resurrected from the indigenous scientific traditions of major non–Western civilizations. Efforts in this direction will enable not merely non–Western but also Western societies to acquire technologies which are highly productive as well as less destructive in their impact on the human, animal and natural world.

We do not argue for a general return to traditional science and traditional technologies in non–Western societies. These were often regressive, particularly as regards the value which must inform a global civilization: the freedom of human beings from exploitation. We seek, instead, to encourage a renewed encounter with other scientific traditions, older and also alternative, within the context of a powerful, open commitment to basic human rights, especially the right to respect and dignity. The aim, concretely, is the reduction of human drudgery, the betterment of the human material condition, the protection of all from insecurity and a genuine freedom to choose. To this end let the traditions and know–how of various civilizations be tapped and marshalled.

A CALL FOR ACTION

As we enter the final two decades of this century, the world's agenda is crowded with international events dealing with the role of science and technology in economic, social and political change: UNCTAD V, the 1979 UN Conference on Science and Technology for Development, UNIDO III and the General Assembly's Special Session on the Third Development Decade in 1980. But there seems to be little inclination among economic, political and scientific elites in either the First and Second Worlds or in the Third World to discuss the critical underlying issues which we have raised in this statement.

Unless the intellectual bankruptcy of world conferences can be arrested and reversed so that these issues are the subject of serious, open and honest debate, such conferences serve no socially redeeming purpose and are actually harmful, because they divert attention and resources from the real problems of human oppression and exploitation. We strongly urge that pressure be built from leading thinkers and scientists, grass–root movements and non–governmental organizations to see that the 1979 Conference on Science and Technology squarely faces the issues raised in this statement, accepts the need for a total reorientation of science and technology, and initiates a process of moving towards a truly liberating role for them.

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II. PUGWASH GUIDELINES FOR INTERNATIONAL SCIENTIFIC COOPERATION FOR DEVELOPMENT

BACKGROUND

The Guidelines for International Scientific Cooperation for Development were drafted at an International Pugwash Workshop on this subject held at Badkal Lake, Haryana, India, 11–14 January 1978. The resulting draft was the responsibility of a Steering Committee entrusted to continue work on the document until a final draft was achieved which would ultimately be submitted to the Pugwash Council for transmission to the United Nations Conference on Science and Technology for Development (UNCSTD), scheduled to be held in Vienna, 20–31 August 1979. The Badkal draft was reviewed by a Pugwash Workshop on the 1979 UNCSTD held in Rabat, Morocco, 20–22 April 1978 and broadly supported. Comments from participants at the Rabat Workshop were incorporated by the Steering Committee, with the present document as a result. The Rabat Workshop recommended that this document be widely circulated to assist in discussions and active preparations for UNCSTD 1979 which are now under way at national, regional and international levels. The present draft should be considered as an interim one pending final approval and official submission by the Pugwash Council to UNCSTD 1979.

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1. PREAMBLE

Science provides special opportunities as an instrument of global solidarity. Moreover, science and its applications provide the tools by means of which, for the first time in history, poverty, ignorance and destitution can be banished from the surface of the earth. This potential could appreciably be enhanced by concrete steps towards Disarmament – the problem which along with that of Development are the major concerns of Pugwash.

At the time of the UN Conference on Science and Technology for the Benefit of Less Developed Areas, held in Geneva in 1963, it was widely believed that a massive transfer of science and technology from the industrialized North would substantially assist in the removal of poverty, hunger and disease in the lesser developed countries of the South. This view has proved to be false.

Access to the technology of the North has proved to be much more difficult than was envisaged. There is now a growing awareness of constraints arising from divergence of interests, real or apparent, and from the structural and operational incompatibilities in the international system. Wide gaps separate many of the developing countries (DCs) from the industrialized countries (ICs), and most DCs have no scientific and technological infrastructure of their own. Consequently, the countries of the South have found it difficult to generate their own technologies, or even to assess and select the right kind of technologies for import, and to take adequate measures to adapt, assimilate and improve upon such technologies as they do acquire from the North. The result has been unfulfilled expectations and perpetuation of dependence which have given rise to a widespread feeling of disillusionment among developing country scientists with past efforts at cooperation with the ICs. It is now recognized that a priority prerequisite for successful cooperation between DCs and ICs is to create capabilities within the DCs which would enable them to face on an equal footing with the ICs the complexities and intricacies of international cooperation in science and technology (S & T).

The prevailing view as the world moves to the close of the Second Development Decade and the UN Conference on Science and Technology for Development (UNCSTD), to be held in 1979, is that countries of the South must build up an *autonomous capability for problem–solving, decision–making and implementation in all matters relating science and technology to Development.* It includes the development of the capabilities to generate, utilize, adapt and diffuse scientific and technological knowledge relevant to their own developmental objectives. *This is the essence of self–reliance in S & T.* Since the achievement of such self–reliance at the national level may not be feasible for many DCs, measures to achieve collective self–reliance of the developing world would be also needed.

The more industrially advanced countries of the North can assist this process in a number of ways. One of these is by means of collaborative scientific and technological projects with countries in the South. Such projects in the past have often been fragmentary in character, uncoordinated with one another, and not properly integrated with either the overall development efforts or the S&T priorities of the developing country concerned. Therefore, while they have helped in the setting up or strengthening of S&T institutions in the South, in the training of S&T manpower, in the generation of new knowledge and in the application of

existing knowledge to some specific developmental problems, they have not by and large contributed significantly to the strengthening or building of local scientific and technological capabilities for problem–solving. Further, they appear at times to have benefited the interests of the countries in the North rather than those of the South, and they have also occasionally led to misunderstandings and abuses.

An important sector (almost half) of the scientific and technological manpower in many ICs is involved in research and development (R&D) for the military and transnational corporations (TNCs). There exists a deep concern among the DCs that their national development may be adversely affected by international collaboration involving such scientists and technologists, possibly biased by their linkages. Further, such growing concentration of scientific and technological manpower and resources in military R&D and in the TNCs, with their built–in constraints, severely limits the scope for international S&T cooperation for development. It also distorts the conditions under which such cooperation takes place.

As the world seeks ways to move from a period of confrontation between the North and the South to more positive cooperation, with the objective of a new International Economic Order, it is likely that many more collaborative projects will be proposed. In order that these may contribute in the most effective manner to the aspirations and developmental objectives of the South and avoid the worst of the previous misunderstandings and abuses, a set of Guidelines for scientific collaboration projects has been prepared. These are conceived as complementary to the Code of Conduct for Transfer of Technology – a previous Pugwash initiative (1974) – which is being evolved at the inter–governmental level within the framework of UNCSTD. These Guidelines are addressed to the Governments and funding agencies of both the North and the South, to international organizations, and to scientists who will be involved in these collaborative ventures.

2. NEW APPROACHES TO DEVELOPMENT AND INTERNATIONAL SCIENTIFIC COOPERATION

International scientific cooperation for Development must be based on a proper understanding of the objectives and character of the development process, and of the limitations of development strategies promoted and pursued in the past. It is now widely recognized that the development strategy followed by DCs during the last three decades needs to be drastically revised. The new strategies of Development have to be based on at least the following principles:

(a) Economic growth by itself does not lead to balanced social development. The principal focus now is explicitly on the satisfaction of basic human needs (adequate food, shelter, health, education and employment, in particular), especially of the lowest social and economic strata of the population.

(b) Meaningful development involves participation of the people themselves in the shaping of economic and social change.

(c) Development is not a linear process, and should not be a mere replication in the DCs of the structures and policies of the ICs. There are many roads to Development – socialist, capitalist and all their possible variations – and the concept of Development should respect the cultural patterns of the DC society concerned, so that its life style does not become an indiscriminate imitation of the experience of the industrialized North.

(d) Mere transfer of technology is not enough. Even if technology were freely available, a nation cannot develop unless it has an S&T base, and the imported technology is absorbed into that base. It is therefore necessary and essential for DCs to be self–reliant, individually wherever possible, and also collectively, so that the very slender S and T resources of most DCs can be pooled to maximum effect.

(e) Development and creative use of indigenous resources of manpower, knowledge, technology and productive capacity, is a pre-requisite for autonomous Development.

(f) Industrialization must not be a mere graft of some industries into a country or a region, whether for export, or for exploitation of local mineral or other resources, or for production of wage goods. Such industrialization does not necessarily lead to Development. Independent viable Development requires much more than 'modernization' of the economy through the establishment of imported industrial plants. Industrialization must be conceived primarily as a means for meeting the basic needs of the local population, with a definite and sustained priority for spreading the benefits to the poorest. Priorities and needs themselves reflect the dynamic evolution of society.

(g) One cannot have two types of science, one good for the DCs and the other for the ICs. DCs must not be satisfied with a derived culture in science which is continually dependent on that of the ICs. Therefore a national capability for basic research is as important for the DCs as for the ICs, though the problems dealt with and the criteria of choice may need to be different.

International Scientific Cooperation for Development

International scientific cooperation for Development should involve:

(i) the promotion of values and a motivation system conducive to such cooperation;

(ii) both the DCs and the ICs taking on a responsibility, individually and collectively, to promote and sustain conditions which will enable DCs to follow a self-reliant strategy in science and technology;

(iii) ensuring that the security of DCs (political, military, economic, etc.) is not jeopardized; and

(iv) the further strengthening of mutual trust and confidence between IC and DC scientists.

Given these considerations, there emerge the following Guidelines for International Scientific Cooperation for Development.

3. GUIDELINES FOR DC GOVERNMENTS AND SCIENTISTS, AND WITH REGARD TO COOPERATION AMONG DCs

The success of international scientific and technological cooperation depends as much, if not more, on the developing countries as on the advanced countries and international organizations. Only when the DCs build up their science and technology capability, identify their own S&T needs and priorities, and expand their capacity to absorb, assimilate, adapt and improve upon imported scientific and technological knowledge, will their cooperation in this field with the outside world become effective and beneficial to all parties involved.

Guidelines for DC Governments

(a) An essential pre-requisite for the build-up of indigenous S and T capability is the realization at the highest policy decision level in the Government that:

(i) such a build-up is a long-term process, to be patiently nurtured;

(ii) it involves the establishment of effective interaction on a durable basis between the S&T community, the educational system, the productive system, and the political system – links which are badly missing in most DCs;

(iii) it cannot be achieved just by training manpower and establishing research centres at random, or uncoordinated use of various technical assistance programmes. Rather it implies the careful construction of a broad-based and viable scientific and technological infrastructure, including managerial capability to organize and utilize it;

(iv) it involves the preparation of a long-term science and technology plan, integrated with the general socio-economic plan, with mechanisms and instrumentalities for implementation;

(v) S&T policy is not just one of the many sectoral of the Government policy but, rather, it is decisive to the future of the whole country and affects the society as a whole;

(vi) it is unrealistic and unproductive to base development strategies on the availability of massive foreign 'aid' (financial, scientific and technological). Local resources and structural and operational mechanisms have to be committed to ensure an integrated and balanced development through an S&T plan enmeshed in the socio-economic plan.

(b) The scientific community, higher education institutions and major science and technology users, both in the public and the private sector, should be actively involved together with government policy makers in the making of national policies, including in particular the preparation of the S&T Plan.

(c) The S&T plan should define the S&T tasks in each socio-economic sector, and the broad priorities and options for intensive domestic effort in S&T. It should also indicate appropriate areas for collaboration, and the possible relevant collaborative projects and inputs from ICs consistent with the priorities and commitments of the overall plan.

(d) The plan should include the S&T implications of a strategy to diversify the economy of the country so that it does not depend only on a few primary products (agricultural or minerals).

(e) The S&T planning process should also address itself to and resolve problems of possible serious conflicts between the proposed S&T policy instruments and specific economic and social policies in force (e.g. fiscal, industrial, labour, agricultural, foreign investment, import of technology), before the highest level decision is taken to make indigenous science and technology capability a major national objective.

(f) Proposals for S&T cooperation should be scrutinized from the point of view of ensuring that dependence of the DC in the area concerned does not get perpetuated. The objective should be to develop indigenous capabilities and self-reliance. Such proposals should not promote the participation of experts or advisers who are not needed, and should give preference to national advisers and experts by themselves or in temporary conjunction with absolutely needed foreign counterparts. Mechanisms other than 'expert-equipment-training' packages should be sought.

(g) In any collaborative undertaking the formulation of the project, and the decision-taking, managerial and evaluation function should always be retained in the hands of DC personnel, even if there is need for initial training.

(h) Cooperative projects should not be conceived as a replacement of existing indigenous endeavours. If such endeavours are inadequate in scope or quality, any collaboration should be directed towards their strengthening and upgrading and not their elimination or undermining.

(i) DC governments should also consider the implications for their policies and actions of the Guidelines suggested later (section 4) for IC governments and international agencies, and establish suitable nodal points for scrutiny of collaborative projects as appropriate.

(j) S&T policy formulation, planning and implementation have to be supported by an appropriate educational and training system and a system of R&D institutions of high quality geared to the needs and demands of a developing society, and by an adequate information and

documentation system. Where this cannot be done nationally, a regional approach could be adopted.*

(k) Non–governmental scientific bodies have to be supported so as to enable them to play an effective role in building an S and T community.

Guidelines for DC Scientists and Technologists

Scientists and technologists from DCs, in order to prepare themselves for the challenges of Development and for fruitful participation in cooperative projects, should:

(a) Organize themselves effectively so as to develop a scientific community in each country which evolves its own internal standards of relevance and recognition of S&T work of merit, and is known and respected for those standards.

(b) Engage themselves not only in scientific research, investigations and communication, but also in efforts to ensure that sustained support for science prevails in the country as a public policy.

(c) Highlight the application of existing knowledge to neglected areas of Development as intellectual challenges, and give due recognition of outstanding work of this kind when considering appointments, career advancement and awards.

(d) Accept identified direct service to society and the economy as a necessary part of their professional activities and as a social obligation.

(e) Take on responsibility, individually and collectively, to promote and sustain conditions which will ensure the self–reliant and autonomous development of the DCs.

(f) Involve themselves in the public debate of Development issues in general and the role of S&T in particular, and build up credibility for S&T as an instrument of Development within their own countries.

(g) Press national policy and decision makers to prepare an S&T plan as an integral part of the plan for socio–economic development, in terms of which scientific and technical manpower

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*The educational system must emphasize not only knowledge and skills, but also attitudes conducive to full participation of the educated (scientists in particular) in the developmental tasks. It has to train high level specialists as well as auxiliary personnel such as technicians, librarians, computer personnel, etc. The courses must combine relevance with excellence, and make education more functional. Production of indigenous books and journals and teaching aids should be promoted to develop self–confidence and self–reliance. Programmes for international cooperation in education and training should derive from national priorities, and be reviewed from the point of view of minimizing the risk of possible alienation of the scientists, and their continued dependence on foreign sponsors.

R&D institutions should be created and strengthened. Dimensions include: proper organization, adequate administrative support, and institutional autonomy; critical size inputs (finance, research and technical staff, equipment), encouraging the emergence of viable groups; computation and data processing facilities; facilities for design, development, fabrication and maintenance of equpment; engineering services; facilities for economic and feasibility studies; and pilot plants to scale up laboratory processes. These institutions should be linked with production and service sectors. Both short–term and long–term programmes should be supported. DC governments should avoid purchase of foreign know–how at a stage when indigenous technology development is about to bear fruit. Local R&D institutions and design engineering organizations should be associated with any acquisition of foreign know–how.

The physical infrastructure and organizations for a national information and documentation system have also to be strengthened. Planning in DCs is often handicapped for want of a reliable data base.

and natural and financial resources may be mobilized for attacking on a sustained basis the S&T problems that have a bearing in meeting basic human needs such as food, shelter, health and education.

(h) Be alert to possible social, economic and political implications of advances in science and technology, and undertake detailed assessments of such implication.

(i) Take an active interest in problems relating to the improvement of the human condition in their own country and other countries, and in current global issues related to the dangers inherent in the energy situation and the rapid depletion of non-renewable resources.

Guidelines for Collaboration among DCs

The DCs cover a wide spectrum of development needs and S&T infrastructure and capabilities. Provided the necessary political will can be generated, DCs can learn much from each other's experience in the application of S&T to Development. It is, therefore, important for DCs to take steps to enhance and enrich their S and T cooperation. With this in view DCs should consider action to:

(a) Promote systematic exchange of information concerning experiences in science policy and planning, building S&T infrastructure, and the acquisition, development and application of S&T knowledge. In this regard regional and sub-regional information centres could be set up.

(b) Establish machinery to facilitate the dissemination and exchange of S&T knowledge and experience originating in the DCs so that their comparative advantages and specializations can be fully utilized.

(c) Make appropriate institutional arrangements for the training and exchange of S&T personnel.

(d) Establish associations of research councils and joint R&D centres in areas of common interest, and machinery for exchange of recently developed S&T knowledge.

(e) Promote the undertaking of S&T projects between DCs with common S&T requirements, whether arising from similarities in their natural endowments, sectoral structures of production, or other factors.

(f) Endeavour to coordinate their S&T policies.

(g) Pool their S&T resources and capabilities for collective self-reliance in S&T for Development.

To facilitate the above, focal points should be established within governments of DCs and international agencies specifically charged with relevant responsibilities.

Cooperation Arrangements between DCs and TNCs

The presence of Transnational Corporations (TNCs) in today's world is as real as the presence of national states. Not only is the economic, scientific and technological capability of many individual TNCs much greater than that of most DCs, but also TNCs control a large part of available modern technology and therefore represent a major potential channel of technology transfer. DCs must search for ways to meet the challenge of TNCs and to use those corporations as effectively as possible to increase the indigenous scientific and technological capability of the DCs. Contrary to conventional wisdom, the traditional technology transfer mechanism of TNCs which consists of a transfer of technical knowledge from a parent TNC in an IC to its subsidiary in a DC does not necessarily increase the S&T capability of the DC. It might even

inhibit its growth, e.g. by attracting to the TNC subsidiary the best local scientific, technological and managerial talents, and using them in line with the objectives of the global TNC system which can be in many ways in conflict with the objectives of a nation state, and particularly a DC.

The existence of national mechanisms aimed at regulating the activities of TNC affiliates, and particularly their technological activities in the host country, represents an essential precondition for any successful scientific and technological arrangement between a DC and a TNC. Such arrangements should specifically aim at: (a) increasing the affiliates' contributions to indigenous scientific and technological education; (b) increasing technological capacity of domestic firms that produce intermediate inputs for the affiliates' production of the final products; and (c) increasing the level of technological knowledge of distributors and users of the capital goods and major consumer durables produced locally by TNC affiliates. Since these objectives cannot be achieved by training activities of DC personnel undertaken by TNC affiliates, the DC governments should consider that these affiliates should:

(i) contract a part of their own R&D needs with local R&D centres;

(ii) permit their personnel to engage in part–time R&D work in local higher level educational and research institutions;

(iii) make available their own R&D facilities for training of scientists and technologists from outside the affiliates; and

(iv) organize technical training programmes for personnel of local sub–contracting firms and local distributors of their products.

Any such contribution of TNC affiliates to local R&D or training programmes in the host country should, however, be consistent with the self–reliant S&T of the DC concerned, and should not be allowed to distort the S&T priorities in the country as defined by the country's S&T plan. Further, many of the considerations enunciated with regard to the cooperation between DCs and ICs (section 4) also apply to the cooperation between DCs and TNCs.

4 GUIDELINES FOR DEVELOPED COUNTRY GOVERNMENTS, FUNDING AGENCIES AND SCIENTISTS

Collaboration between an IC and a DC may lead to the generation of new knowledge of specific relevance for development, it may lead to the building up of local scientific and technological capabilities in developing countries, or it may be collaboration for the application of existing knowledge to development objectives. Guidelines pertaining to commercial transactions of technology are excluded as they are covered by the Code of Conduct for Transfer of Technology being negotiated within UNCTAD.

Guidelines to Governments and Funding Agencies

(a) Priority should be given to those projects which contribute most to the building up of local scientific and technological capabilities in developing countries.

(b) The choice and manner of implementation of specific collaborative projects should accord with the development priorities which are determined by the developing countries themselves, and are reflected in the commitment of their own resources. Therefore IC governments and agencies should channel their funds for cooperative projects through the national authorities of DCs.

(c) Training programmes for DC nationals should be provided primarily in those areas and

disciplines for which there is a clearly defined need in the developing countries as determined by DCs themselves.

(d) The leader of a project undertaken in a developing country should be a national of that country who should be responsible for its management and technical control. When this is not possible, the first phase of the project should include the training of both managerial and technical directors.

(e) The choice of any foreign consultant required by the developing country partner in the collaboration should be made by the developing country, and should not be imposed by the IC partner.

(f) Sponsoring agencies in ICs should stipulate that any S&T cooperative project in DCs should be undertaken jointly with local institutions.

(g) Collaborative projects carried out in developed country laboratories or institutions should involve scientists from the participating developing country, and it should be ensured that the results of such projects flow to, and are applied in, the DC concerned on a preferential basis.

(h) When the results of collaborative research can be commercially exploited the DC partner should have the priority of patenting and using those results.

(i) The dissemination of raw data collected in a developing country in the course of a collaborative project should be at the discretion of the developing country partner. Publication of the analysis and conclusions should be a joint undertaking.

(j) A collaborative project should be viewed and integrated within the framework of a long-term development programme as defined by the developing country.

(k) Collaborative programmes must not be used to exploit DCs as testing grounds for new scientific concepts or technical innovations that cannot be carried out in the DCs.

(l) Whenever a collaborative project involves the trial of drugs, chemosterialants, pesticides, etc. in a developing country, these trials should conform not only to the current regulations and ethical requirements in the developing country but also to the regulations of the developed country and/or those accepted internationally (unless an explicit decision to the contrary is taken by the developing country partner – as in the case of DDT in some countries).

(m) Identification and assessment of the ecological implications of collaborative programmes should be a part of the programme itself. Collaborative research conducted in a DC should be not only in accordance with the DC's own environmental standards, but also with international environmental standards as well.

(n) Collaborative programmes should allow for mechanisms other than the 'expert–equipment–training' package.

(o) S&T cooperation must not be used to impose any particular political or economic system on a DC.

Guidelines for Scientists and Technologists from Developed Countries

Those scientists and technologists from the developed countries who participate in collaborative projects in developing countries should:

(a) Ensure that their work is for the benefit of the developing countries, and not for other conflicting purposes.

(b) Do their utmost to contribute to the building up of the local scientific and technological capabilities in the developing countries, so that the developing countries are able to run their own scientific and technical programmes without continuous foreign inputs as soon as possible.

(c) Draw the attention of developing country agencies or governments to the existence of

local expertise in the speciality of the IC scientists of which those government agencies may not be aware.

(d) Refrain from using the guise of a collaborative project with a developing country in order to use developing country scientists to collect data and conduct surveys for the prime benefit of their own research, rather than for the benefit of the developing country.

(e) Be continuously aware of the political and economic constraints imposed on their freedom for credible S&T cooperation with their counterparts from DCs. These constraints arise from their dependence on governmental and industry liaison for their work. In the interest of viable international scientific cooperation this situation should be questioned and alternatives sought for. Be alert to the possible social, economic and political implications for developing countries of advances in science and technology, and undertake detailed assessments of such implications of relevant advances in collaboration with DC scientist.

5. GUIDELINES FOR INTERNATIONAL COOPERATION UNDER THE AUSPICES OF INTERNATIONAL AND REGIONAL ORGANIZATIONS

The part played by international organizations in scientific cooperation for Development is being debated. There is an urgent need for restructuring the UN system and other international organizations dealing with S&T cooperation for Development, and to remedy their manifold shortcomings, especially to meet the requirements of the New International Economic Order.*

The success of all international scientific cooperation endeavours should be judged by the extent to which the indigenous scientific and technological capabilities of DCs have been enhanced and expanded.

To achieve this end, the following guidelines are suggested for S&T cooperation under the auspices of international organizations (UN and others). These are additional to the guidelines alredy recommended for IC scientists and governments in section 4.

International Agencies

(a) Cooperative projects undertaken with the involvement of international agencies should be derived from the national plans and/or priorities of the DCs, and provide for flexibility to adapt to changing conditions.

(b) Cooperation under UN auspices and with other international organizations should ensure the upgrading of the policy-making and managerial capabilities and the infrastructure necessary for the proper growth of S&T.

(c) Such projects should have a substantial component aimed at enhancing the internal S and T capabilities and self-reliance of DCs, and for rectifying their technological dependence on foreign entities.

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*Some of the factors that determine the success or failure of such international cooperation relate to: correct goal setting; proper identification and formulation of projects which are dovetailed into national plans; the extent to which the fragmentary agency-based approach taken within the UN system is overcome; choice of experts and their competence; operational delays due to the local administrative procedures and lack of proper counterparts in DCs; and the quality and relevance of the project management methods used. These political, structural and operational constraints of international organizations have to be reckoned with when defining the objectives of and instrumentalities for effective international scientific cooperation for Development.

(d) Inputs for organizations of the UN system should be coordinated so as to have an integrated impact on the overall national Development programmes of DCs, both vertically with other projects of the same organization, and horizontally with relevant projects of other UN organizations.

(e) International organizations should provide all support to DCs for ensuring that local scientific personnel take over at the earliest opportunity the responsibility for continued execution of a project launched through international cooperation.

(f) Greater use should be made by international organizations of the expertise in the DCs themselves, including consultancy organizations of all kinds.

(g) When a programme of S&T cooperation under the auspices of the international organizations needs only equipment or training and does not require outside experts, acceptance of 'experts' as part of the project should not be insisted upon.

(h) Training is best accomplished within the milieux of the developing countries themselves. Where outside S&T training is needed, regional facilities and capabilities should first be utilized fully. Where training in ICs occurs, adequate steps should be taken to ensure the return of the scientist to his own country, except where political persecution may be involved.

(i) S&T cooperation programmes of international organizations should not lend themselves to commercial promotion of products or processes made by a firm of any country.

(j) International organizations should not depend on the TNCs for the major funding of any part of their activities. Wherever any such contribution is made by TNCs it should be without strings attached, and the nature and scope of the contribution should be made fully public.

(k) International organizations should not provide 'cover' (act as proxy) for research projects conducted in a country at the instance of a third party. In such cases all explicit information about the interest of the third party should be made available.

Regional and Inter-regional organizations

Exchange of experience and cooperative projects between and among developing countries should be encouraged and fostered with a view to building up their collective self-reliance. Regional centres are valuable devices for pooling resources, talents and facilities and for tackling problems of mutual regional interest through a network of collaborating institutions from each participating country. This is particularly pertinent where facilities would prove to be expensive and difficult to establish in any single country.

Issues related to Development are essentially global, and they encompass the well-being of all mankind. Meaningful international scientific cooperation in relation to the challenges of Development demands the adoption of a rational and collaborative approach, so characteristic of science. Its appeal is to the social responsibility of scientists, and it calls for scientific humanism of a high order. The Guidelines presented here should not only help strengthen international scientific cooperation in this sensitive area and help surmount the problems of poverty and dependence of the DCs, but they should also help build bridges between societies with different social, economic and political systems.

Transaction Books of Related Interest

The Limits of Technocratic Politics
Jeffrey D. Straussman

As knowledge and expertise become increasingly central to the guidance of social change, experts become indispensable to policymakers. Ultimately technocratic experts will dominate the policymaking process. Straussman questions the controversial aspect of the knowledge-is-power thesis by looking at the United States from 1961 through 1974—from Camelot to Watergate. All these technocratic movements have one element in common: they assume that by improving the policymaking process through the use of knowledge and expertise, it is possible to improve the performance of government.

164 pages; 1979; ISBN: 0-87855-173-5 (cloth), ISBN: 0-87855-625-7 (paper)

Human Rights and World Order
Edited by Abdul Said

This anthology is an exciting and vibrant contribution to the ongoing debate about international human rights. Drawn largely on materials published in the Fifteenth Anniversary issue of *Society* magazine, but incorporating outside essays as well, the editor has assembled a collection of articles written by noted scholars and policymakers, an introduction by the editor and a statement by Irving Louis Horowitz, editor-in-chief of *Society* magazine. The articles approach the theme of human rights from a variety of perspectives, including the United Nations and nongovernmental organizations, children's rights, media coverage of human rights conflicts, and the interplay between human rights and world resources.

250 pages; 1979; ISBN: 0-87855-718-0 (paper)

The New Class?
Edited by Barry Bruce-Briggs

This pioneering effort to establish the existence or nonexistence of such a New Class is destined to represent a classic breakthrough in the literature on politics and stratification. The idea of the New Class has taken many forms over the past century. Whatever ambiguities exist at the definitional level, it has become apparent that elite positions—the conferring of income, status, and power—are increasingly being held by virtue of the possession of education rather than the traditional attributes of wealth and/or personal moral virtues. Current data suggest a relative decay of proprietorship, expansion of salaried managers and professionals, rapid growth of health and welfare industries, and—most significant from the viewpoint of a New Class—the ballooning of academia and the emergence of well-paid and highly educated federal officials.

225 pages; 1979; ISBN: 0-87855-306-1 (cloth), ISBN: 0-87855-725-3 (paper)